Olin Corporation

Wilmington, MA

Supplemental Phase II Report

Volume VIII

June 1997

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Olin Corporation

Wilmington, Massachusetts Facility

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Appendix S

APPENDIX S

STAGE II - ENVIRONMENTAL RISK CHARACTERIZATION

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION
51 EAMES STREET
WILMINGTON, MA
RELEASE TRACKING NO: 3-0471

JUNE 1997

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION WILMINGTON FACILITY

DEP RTN: 3-0471

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STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
RELEASE TRACKING NO. 3-0471
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LIST OF ACRONYMS

ABB-ES	ABB Environmental Services, Inc.
ANOEC	acute no observed effect concentration
ASAS	Applicable or Suitably Analogous Standards
ASTM	American Society for Testing and Materials
BHC	benzene hexachloride
CMR	Code of Massachusetts Regulations
CRA	Conestoga-Rovers & Associates
CSA	Comprehensive Site Assessment
EPC	Exposure Point Concentrations
ERC	Environmental Risk Characterization
FETAX	Frog Embryo Teratogenesis Assay - Xenopus
HI	Hazard Index
HQ	Hazard Quotient
LOEC	Lowest Observed Effect Concentration
MADEP	Massachusetts Department of Environmental Protection
MCP	Massachusetts Contingency Plan
MDFW	Massachusetts Division of Fisheries and Wildlife
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
NCP	National Contingency Plan
NHESP	Natural Heritage and Endangered Species Program
NPI	National Polychemical Company, Inc
OHM	Oil and Hazardous Material
OHMPC	OHM of Potential Concern
PAH	polynuclear aromatic hydrocarbons
PCB	polychlorinated biphenyl
QSAR	quantitative structure-activity relationship
RTN	Release Tracking Number
RTV	Reference Toxicity Values

LIST OF ACRONYMS (Continued)

SFF	Site Foraging Factor
SQL	Sample Quantitation Limits
SVOC	Semivolatile Organic Compound
SWMU	solid waste management unit
TAL	target analyte list
TCL	target compound list
TIE	Toxics Identification Evaluation
USFWS	United States Fish and Wildlife Service
VOC	Volatile Organic Compound

EXECUTIVE SUMMARY

An environmental risk characterization (ERC) was conducted to assess the risks to ecological receptors posed by oil and hazardous material (OHM) detected at or having migrated from the Wilmington Facility. The primary goal of the risk characterization was to determine whether there is an indication of the potential for ecological harm and/or evidence of ecological harm associated with OHM at the facility.

This risk characterization uses the information compiled during the Phase II Comprehensive Site Assessment (CSA) performed by Conestoga-Rovers & Associates (CRA) for Olin Corporation (CRA, 1993) and the Supplemental Phase II Site Investigation performed by Smith Technology, Inc. (1997).

E.1 ENVIRONMENTAL RISK CHARACTERIZATION APPROACH

This ERC was conducted in a manner consistent with the Massachusetts Department of Environmental Protection's (MADEP) Guidance for Disposal Site Risk Characterization, Interim Final Policy (WSC/ORS-95-141) (MADEP, 1995) and the "Method 3- Environmental Risk Characterization" published in April 1996, which comprised Chapter 9 of the Interim Final Policy. This policy provides additional guidance to that contained within the regulations (310 CMR 40.0995 (4)) in the Massachusetts Contingency Plan (MCP) regarding the conduct of environmental risk characterizations. This ERC is also consistent with the "Scope of Work, Stage II Environmental Risk Characterization; Olin Corporation Wilmington Facility, DEP RTN: 3-0471" dated January 1997 (Olin, 1997) and reviewed and conditionally approved by MADEP (MADEP, 1997a).

Media evaluated at the site included surface soil, surface water, and sediment. Surface soil was evaluated for all areas at the facility containing suitable terrestrial habitat. Surface water and sediment were evaluated separately for five areas at the facility (On-Property West Ditch, Off-Property West Ditch, South Ditch, Ephemeral Drainage, and Central Pond). The East Ditch that parallels the railroad tracks was not evaluated because it provides minimal cover and contains few prey items to attract foraging wildlife.

Representative ecological receptors evaluated were the green frog, green heron, American woodcock, and red fox.

In order to obtain site-specific information regarding exposure and toxicity, both biological tissue sampling and toxicity tests were performed. Biological tissue samples were chemically analyzed, and the analytical data were incorporated into food chain models used to help characterize risks to semi-aquatic and terrestrial wildlife receptors. Earthworm toxicity tests were conducted in which laboratory-reared earthworms were exposed to surface soil samples from the site. The results of the earthworm tests were used to help characterize risks to terrestrial wildlife receptors that may rely on soil invertebrates as prey items. Earthworm tissue concentrations were also obtained from these tests which were incorporated into the food chain model. A type of frog toxicity test, referred to as the Frog Embryo Teratogenesis Assay - Xenopus (FETAX) test, was conducted in which frog embryos were exposed to sediment elutriate samples from the site. The results of the FETAX tests were used to help characterize risks to amphibians as representative aquatic receptors, and to semi-aquatic receptors that may rely on amphibians as prey items.

A population model was used to help relate the results of the toxicity tests, which looked at embryo mortality and malformation, to potential population-level impacts.

E.2 ENVIRONMENTAL RISK CHARACTERIZATION FINDINGS

E.2.1 Aquatic Receptors

Risks to aquatic receptors (i.e., the green frog) were evaluated based on results of FETAX toxicity tests, results of a population model, field observations, and concentrations of OHM of Potential Concern (OHMPCs) in surface water and sediment elutriate relative to published reference toxicity values (RTVs). Table 49 contains a summary of the risk evaluation for the green frog. The results of the toxicity tests indicate significant toxicity at two locations in the On-Property West Ditch. The population model, which incorporated the results of the toxicity tests, indicated a greater than 25% reduction in frog subpopulations in the On-Property West Ditch. These results are given greater consideration in the overall weight of evidence evaluation because they are based on site-specific information and a model which directly relates the results of the toxicity tests to a population level effect, which is the selected assessment endpoint. Sediment elutriate concentrations were compared with amphibian RTVs in an attempt to identify chemicals responsible for the toxicity observed in the tests. No trends were noted, and a regression analysis indicated that there is no correlation between any of the OHMPCs and the observed toxicity.

A comparison of surface water concentrations with amphibian RTVs resulted in Hazard Indices (HIs) greater than 1, particularly in the Off-Property West Ditch, South Ditch, and Ephemeral Ditch areas. Chromium, ammonia, and di-n-octyl phthalate are risk contributors for historical data. Concentrations and associated HIs for recent data are considerably lower than historical data in both the Off-Property West Ditch and the Ephemeral Ditch. The primary site-related risk contributor from the more recent data is ammonia. Aluminum and iron are also identified as potential risk contributors. The results of the ERC do not support a conclusion of no significant risk of harm to aquatic receptors.

E.2.2 Semi-Aquatic Wildlife Receptors

Risks to semi-aquatic wildlife receptors (i.e., the green heron) associated with exposures to OHMPC were evaluated based on results of a food chain model, which evaluated food chain exposures based on site-specific tissue concentrations for likely prey items (e.g., frogs and crayfish), as well as surface water and sediment ingestion exposures. Table 51 contains a summary of the risk evaluation for the green heron. Results of the model indicated that HIs for each of the ditch areas evaluated are less than one, indicating that there is no significant risk of harm to semi-aquatic receptors from exposure to OHMPCs at the site. Indirect impacts to semi-aquatic wildlife receptors from reduced prey abundance were also evaluated, based on the FETAX toxicity test results that were incorporated into the frog population model. A 50% reduction in abundance is unlikely at all locations except possibly the On-Property West Ditch. This ditch comprises only a portion of potential habitat for the heron at the site, and since a significant reduction in prey items at other areas of the site is not predicted, an overall 50% reduction in abundance is unlikely. The results of the ERC support a conclusion of no significant risk of harm to semi-aquatic wildlife receptors.

E.2.3 Terrestrial Wildlife Receptors

Risks to terrestrial wildlife receptors (i.e., the woodcock and red fox) associated with exposures to OHMPC were evaluated based on results of a food chain model, which incorporates site-specific tissue concentrations for likely prey items (e.g., earthworms and small mammals) as well as incidental ingestion of surface soil. Table 54 contains a summary of the risk evaluation for terrestrial wildlife. Results of the model indicated that the HI for the fox is below 1, while that for the woodcock is 1.9. All OHMPC-specific Hazard Quotients (HQs) for the woodcock were below 1; the analyte contributing the most to this HI is aluminum, with an HQ of 0.83. These results support a conclusion of no significant risk of harm to terrestrial wildlife receptors at the site.

Indirect impacts to terrestrial wildlife receptors from reduced prey abundance were also evaluated based on the earthworm toxicity test results. No significant toxicity was observed in any of the soil samples tested. However, in the chronic earthworm toxicity test, potential reproductive effects were indicated by low cocoon production relative to the laboratory control. Low cocoon production was also noted in the reference location. This low cocoon production does not appear to be chemically related, as it was similar at all locations tested, regardless of chemical concentrations present in the samples used for the tests. Low cocoon production is attributed to a reflection of differences in the physical characteristics of the local soils (grain size, percent clay, amount of organic material) relative to those of the formulated soil used in the laboratory control. The overall results of this evaluation indicate that there is no significant risk of harm to terrestrial wildlife receptors from reduced prey abundance resulting from exposure to OHMPCs at the site.

E.2.4 Comparison To ASASs

Surface water concentrations of several inorganics, including aluminum, chromium, copper, iron, lead, and ammonia at one or more surface water locations at the site exceed Massachusetts Surface Water Quality Standards, which are considered Applicable or Suitably

Analogous Standards (ASASs). Because these ASASs are exceeded, the MCP states that a condition of no significant risk of harm to the environment has not been achieved. These ASASs consist of criteria which are not truly appropriate for the types of aquatic receptors that would occur in surface water bodies at this site, because they are protective of sensitive cold water fish species such as trout which would not be expected to occur at this site, and they should therefore be given a low overall weight of evidence relative to the other findings of this ERC.

E.3 CONCLUSIONS

The results of the ERC support a finding of no significant risk of harm to terrestrial and semi-aquatic receptors at the Olin Wilmington Facility. However, for aquatic receptors, a condition of no significant risk of harm to the environment does not exist. Future studies or remedial actions should focus on addressing sediment-related risks in the On-Property West Ditch (i.e., a Tier 1 Toxicity Identification Evaluation [TIE]), and potential surface water-related risks in the Off-Property West Ditch, South Ditch, and Ephemeral Drainage Areas.

1.0 INTRODUCTION

Olin Corporation (Olin) has conducted a Method 3, Stage II Environmental Risk Characterization (ERC) for the disposal site at the former manufacturing facility location at 51 Eames Street in Wilmington, Massachusetts (the Facility). This site (RTN: 3-0471) is a Tier IA disposal site under the Massachusetts Contingency Plan (MCP, 310 CMR 40.0000). This ERC is prepared in accordance with the MCP (310 CMR 900) and the "Scope of Work, Stage II Environmental Risk Characterization, Olin Corporation Wilmington Facility, DEP RTN: 3-0471" dated January 1997 (Olin, 1997) and reviewed and conditionally approved by Massachusetts Department of Environmental Protection (MADEP, 1997a). This ERC is also in substantial compliance with the National Contingency Plan (NCP, 1990).

This ERC uses the information compiled during the Phase II Comprehensive Site Assessment (CSA) performed by Conestoga-Rovers & Associates (CRA) for Olin Corporation (CRA,1993) and relies heavily on information compiled during the Supplemental Phase II Site Investigation performed by Smith Technology, Inc. (Smith, 1997), as well as information initially presented in the Screening Level Environmental Risk Assessment (ABB Environmental Services, Inc. [ABB-ES], 1993), to assess the risks to ecological receptors posed by contaminants detected at the Wilmington Facility. Risks to human health are addressed in a separate document.

This ERC was conducted in a manner consistent with the MADEP's Guidance for Disposal Site Risk Characterization, Interim Final Policy (WSC/ORS-95-141) (MADEP, 1995a) and the "Method 3- Environmental Risk Characterization" published in April 1996, which comprises Chapter 9 of the Interim Final Policy. This policy provides additional guidance to that contained within the regulations (310 CMR 40.0995(4)) regarding the conduct of environmental risk characterizations.

The Stage II ERC was conducted to determine whether there is an indication of the potential for ecological harm and/or evidence of ecological harm associated with oil and/or hazardous materials at the Facility. The ERC builds upon information presented in the Method 3, Stage I Screening Level Environmental Risk Assessment (ERA) conducted by Olin in 1993 (ABB-ES, 1993). Additional information, collected subsequent to the Stage I ERA, regarding background levels of contaminants in surface water and sediment and additional analytical data for Facility surface soils, sediments, and surface waters were used to identify Oil and Hazardous Material (OHM) of potential concern. In addition, this ERC includes an evaluation of site-specific biological tissue and toxicity data, which were used to develop risk estimates for ecological receptors.

Under the MCP, the Method 3, Stage I Environmental Screening is a simple comparison of maximum concentrations of site-related contaminants to readily available screening criteria to provide an evaluation of the presence or absence of potential ecological risks. The ERA conducted in 1993, which was equivalent to a Stage I Environmental Screening, indicated that pesticides and several inorganic contaminants (primarily chromium, but also arsenic and lead) detected in aquatic media at the Facility exceed screening benchmark values for aquatic receptors. The purpose of this ERC is to provide a comprehensive evaluation of risks to environmental receptors. Figures 1 and 2 present the risk characterization process flow for aquatic and terrestrial habitats at the Facility, respectively.

As indicated in Figures 1 and 2, additional studies were conducted in order to gain site-specific information regarding the type and magnitude of ecological exposures and effects at the Facility, and to reduce uncertainties associated with the risk characterization process. The additional field studies and biological sampling conducted in support of this ERC are discussed in Attachment 1.

The remainder of this document includes the three general steps of an ERC and a summary and conclusions:

1. Problem Formulation (Section 2.0)
2. Analysis (Section 3.0)
3. Risk Characterization (Section 4.0)
4. Summary and Conclusions (Section 5.0)

2.0 PROBLEM FORMULATION

Problem formulation is the initial step of the ERC process where the purpose and scope of the assessment are defined. This problem formulation contains a brief site history (Subsection 2.1), a discussion of the nature and distribution of OHM (Subsection 2.2), identification of OHM of potential concern (OHMPC) (Subsection 2.3), identification of ecological receptors and exposure pathways (Subsection 2.4), conceptual model development (Subsection 2.5), and the selection of assessment and measurement endpoints (Subsection 2.6). With the exception of Subsection 2.2, much of the problem formulation for this ERC was completed during the development of the Environmental Risk Characterization Scope of Work (Olin, 1997).

2.1 SITE HISTORY

The Wilmington Facility (Facility), located at 51 Eames Street, Wilmington, Massachusetts (Figure 3), is currently owned by Olin Chemical Corporation. The following brief description of the Facility was taken from the Phase II report (CRA, 1993). The 53-acre Facility is a former chemical manufacturing plant. The Facility is located in a heavily industrialized area. Located to the east, west, and north of the Facility are heavy and/or light industries; to the south is the old Woburn Town Dump. The Facility was owned by National Polychemical Company, Inc. (NPI) from its construction in 1953 until 1960. In about 1960, NPI was transferred to American Biltrite Rubber which operated NPI until 1964. Stepan Chemical Company acquired NPI and the plant in 1968 and merged NPI into Stepan in 1971. Olin purchased the plant in 1980 and closed it in

September, 1986. Types of chemicals produced included chemical blowing agents, stabilizers, antioxidants, and other specialty chemicals for the rubber and plastics industry.

Figure 4 presents the site features at the Olin Facility. Prior to 1970, liquid waste generated by the Facility was diverted into a series of three acid pits, two unlined pits, or into the "Lake Poly Liquid Waste Disposal Area", which is located along the western boundary of the facility. In 1970, two PVC-lined lagoons were constructed over the existing acid pits. Sulfate-bearing liquid waste was mixed with calcium hydroxide slurry to form a sludge that was disposed of in the lagoons. Solids from the lagoons were dredged periodically and were landfilled in the Calcium Sulfate Landfill in the southwest corner of the facility. Olin excavated Lagoon I in 1981 and Lagoon II in 1983 and relined them. In 1986, the lagoon system was drained, solids were dredged, liners were removed, and the lagoons were covered with fill and abandoned. The dredged materials were disposed of in the Calcium Sulfate Landfill, and closure activities were completed in approximately 1988.

Another potential source of OHM release is the "Plant B" area in the northeast portion of the Facility. Materials allegedly spilled in the area include di-isobutylene (trimethylpentenes), diphenylamine, bis-2-ethylhexylphthalate (processing oil), dioctylphthalate, dioctyldiphenyl-amine, and fuel oil. When Olin purchased the Facility in 1980, the Plant B tank farm sat on grade with no perimeter dike or spill containment system. Olin removed soils for off-site disposal and installed a secondary containment system consisting of a concrete base slab and perimeter curbing. Subsequently, Olin has installed extraction wells to provide hydraulic containment of a non-aqueous phase processing oil and to extract contaminated groundwater. The extracted groundwater is currently treated by overchlorination to remove ammonia, pH adjustment to precipitate iron, and with granular activated charcoal to remove organics. The treated groundwater is discharged to the On-Property West Ditch through an NPDES-permitted outfall.

2.2 NATURE AND DISTRIBUTION OF OHM

In this section of the ERC, analytical data available for surface soil, surface water, sediment, and biological tissue are summarized, and OHMPC are identified.

Analytical data suggest that historical activities at the facility associated with various manufacturing processes have resulted in OHM in surface soil at the facility, as well as in sediment found within the series of man-made drainage ditches within and adjacent to the Facility (Figure 5). These ditches were likely contaminated as a result of direct discharge from the Lake Poly Liquid Waste Disposal Area, the acid pits, and the two unlined pits, as well as overland surface runoff and discharge of shallow groundwater.

Sampled media include surface soil, subsurface soil, surface water, sediment, and floc material collected within the fenced area of the Facility; surface water and sediment collected from beyond the fenced perimeter of the Facility (East Ditch, Off-Property West Ditch); and groundwater (both on-property and off-property). On-property drummed waste was also sampled in the Phase II Comprehensive Assessment. All data collected in the Phase II Comprehensive Site Assessment, as well as a complete description of the sampling programs, are presented in the Phase II report (CRA, 1993), and all data collected in the Supplemental Phase II Site Assessment are presented in the Supplemental Phase II Report (Smith, 1997). In addition to these media, biological tissue samples were also collected and analyzed as part of this ERC. Attachment 1 contains a detailed discussion of the biological sampling program.

For the samples selected for this ERC, Tables 1 through 5 present data summaries for the OHM (Volatile Organic Compounds [VOCs], Semivolatile Organic Compounds [SVOCs], pesticides/polychlorinated biphenyls [PCBs], inorganics) detected in the sampled media (surface soil, surface water [unfiltered and filtered recent, and unfiltered historical], and sediment). Biological tissue data are presented in Tables A1-1 though A1-5 in Attachment 1. Groundwater data are not included in this ERC because there is no direct pathway for ecological receptors to be exposed to groundwater; surface water and sediment data are presumed to reflect the influence of groundwater on these media.

The range of Sample Quantitation Limits (SQLs), frequency of detection, range of detected concentrations, arithmetic mean of all samples with one-half the SQL assigned to non-detects, and background concentration (where available) are presented for each chemical. The following sections describe the data collection and data summarization activities for surface soil, surface water, sediment, and biological tissue data. To simplify the discussion of these data, the sample locations are identified even though multiple samples may have been collected at a given surface water or sediment location. All samples used in this ERC are identified in Attachment 2.

2.2.1 Surface Soil

In 1991, CRA collected 14 surface soil samples (including one duplicate). Ten composite samples (plus one duplicate) were collected from an approximately 200 foot grid as shown on Figure 5. Each of these samples (designated Area 01 through Area 10) comprises four grab samples collected within the grid area. Three additional composite samples (each consisting of three grab samples) were collected and designated SWMU-27, SWMU-30, and SWMU-33. All 1991 samples were collected from zero to six inches below ground surface. Five of the ten composite samples (Area 01, 02, 03,08, 09) were quantitatively evaluated in the ERC, as they were collected from areas containing suitable ecological habitat. The three additional samples from SWMU-27, SWMU-30, and SWMU-33 were also utilized in the ERC.

In 1993, a composite surface soil sample (two grab samples), was collected and designated SWMU-25 in the area of Plant B. However, this sample was not evaluated in the ERC, as it was collected from an area of the site dominated by managed areas (i.e., mowed grass, pavement, and buildings) unsuitable for ecological receptors identified at the site.

In 1996, Smith collected 54 additional surface soil samples, including two field duplicates (shown on Figure 5) to characterize conditions at additional locations on the Olin property. Ten surface soil samples (CPDA-1 through CPDA-9, plus one duplicate) were collected in the two Central Pond drainage areas within grid area 8. Four grab samples (G1-DRMB through G4-DRMB [analyzed only for volatiles]) and one composite sample (DRMB) were collected in Drum Area B. Four grab samples (GA1-DRMA through GA4-DRMA [analyzed only for volatiles]) and one composite sample (DRMA [COMPA]) were collected from Area A of Drum Area A. Area A within Drum Area A is in the vicinity of Test Pit 8. Four grab samples (GB1-DRMA through GB4-DRMA [analyzed only for volatiles]) and one composite sample (DRMA [COMPB]) were collected in Area B of Drum Area A. Area B of Drum Area A is in the vicinity of Test Pits 6 and 7. Three samples and a duplicate (Lake Poly-1 through Lake Poly-3) were collected in the area of the Lake Poly Liquid Waste Disposal Area. Nine surface soil samples were collected in the central wetland area that spans grid areas 8 and 9 (A8CW-1 through A8CW-4, A9CW-1 through A9CW-4, and A9CW-[COMP]). In addition, six grab samples and one composite sample (Area 1-1 through Area 1-6 and Area 1 COMP) were collected in grid area 1. In 1996, four additional grab samples (Area 8-1 through Area 8-4) were collected around the Central Pond in grid area 8.

The samples collected from Area A and Area B of Drum Area A and the four samples collected in the vicinity of Lake Poly were not evaluated in the ERC. These samples were eliminated from the ERC, as they fall within areas of the site which do not contain habitats of ecological significance. Eliminating these samples left a subset of 35 soil samples (from the total of 54 samples collected at the site) which were utilized in the ERC.

In 1997, ABB-ES collected seven surface soil samples from the property as shown on Figure 5. These samples were collected to support earthworm toxicity testing. One sample (BS021REF) was collected at an off-property reference location and is therefore not used here to characterize site exposure. Two samples (BS013WDX and BS014WDX) were collected in the area of SWMU-27 and the On-Property West Ditch. One sample (BS015SDX) was collected within SWMU-30 along the South Ditch and another sample (BS016SMD) was collected near SWMU-33 south of the Ephemeral Drainage. Two additional surface soil samples (BS017PND and BS018PND) were collected in the area of the Central Pond. All of the samples collected in 1997 were included in the ERC.

Surface soil samples were analyzed for the full target compound list/target analyte list (TCL/TAL) parameters plus 2,4,4-trimethylpentenes, ammonia, chloride and sulfate. A subset of surface soil samples collected at the site was included in the ERC; the surface soil samples that were used in the ERC are presented in Table A2-1 in Attachment 2. Surface soil analytical data from these samples are summarized in Table 1.

The background soil sampling locations and analyte concentrations are presented in Section 4.1 of the Supplemental Phase II Report and are also presented in Attachment 3. The seven soil background sampling locations are off-property, as shown in Figure 6. The median and maximum concentrations for site-specific background analytes and the published MADEP soil background concentrations are shown in Table A3-1 in Attachment 3. Site-specific soil background concentrations were characterized for ammonia, calcium, potassium, sulfate, nitrate, and polynuclear aromatic hydrocarbon (PAH) compounds. MADEP-published background soil concentrations (MADEP, 1995a) were used for the remaining metals and inorganics.

A surface soil sample was collected from SWMU 27 (an area of high chromium concentration) to determine the proportion of hexavalent chromium versus total chromium. A concentration of 280J milligrams per kilogram (mg/kg) of total chromium and 17J mg/kg for hexavalent chromium was reported in this sample, indicating that hexavalent chromium is less than 10 percent of total chromium concentrations.

2.2.2 Surface Water

In 1992, two rounds of sampling (a total of 45 samples, including 3 duplicates) were conducted at locations SW-01 through SW-18 (duplicates were collected at SW-06 [second round] and SW-17 [first and second rounds] [two samples at each location] and SW-19 through SW-24 [one sample at each location]). Numerous surface water samples were collected prior to 1992, but these data are outdated and not suitable for the risk assessment. > 1992 not used.

A subset of 19 surface water samples were selected from the 45 samples collected in 1992 for quantitative evaluation in the ERC. These samples were identified as unfiltered historical surface water samples. Samples from this subset were separated and summarized by aquatic study area for evaluation in the ERC. The aquatic study areas included the Off-Property West Ditch, South Ditch, Ephemeral Drainage, and On-Property West Ditch. The samples used to evaluate the Off-Property West Ditch included SW-14 through SW-17 (and its duplicate) and "No POND"

SW-18. Samples used to evaluate the South Ditch included SW-06 (and its duplicate) through SW-11, and SW-19. Samples used to evaluate the Ephemeral Drainage included SW-20, SW-21, and SW-22. The samples used to evaluate the On-Property West Ditch included SW-12 and SW-13.

In early 1993, one round of sampling (a total of six samples) was conducted at locations SW-25 through SW-30 in the East Ditch. However, these samples were not evaluated in the ERC. The sample locations fall outside the area evaluated in the ERC because there is no significant habitat in the East Ditch.

Surface water samples collected in 1992 and 1993 were analyzed for miscellaneous parameters, inorganics, metals, pesticides and PCBs, volatiles (including trimethylpentenes), and semivolatiles.

Throughout 1995, 25 filtered and 24 unfiltered surface water samples were collected at locations designated by Geomega as SW-11, SW-12, SW-14, SW-15, SW-16, SW-17 and SW-18. The Geomega sampling locations and identifiers do not correspond to the previously sampled locations with those identifiers. In the Supplemental Phase II Report, these sample identifiers were modified by adding a "-95" to the end. In this ERC, any Geomega sample collected at a previously sampled surface water location was assigned the location identifier of the historical location to help with data summarization. Any Geomega samples not collected at a historical sampling location were assigned a location identifier beginning with "G" and use the Geomega numerical surface water sampling location identifier as shown below.

GEOMEGA IDENTIFIER	SUPPLEMENTAL PHASE II INVESTIGATION IDENTIFIER	CSA IDENTIFIER	NEW LOCATION IDENTIFIER
SW-11	SW-11-95	SW-15	SW-15
SW-12	SW-12-95		GSW-12
SW-14	SW-14-95	SW-18	SW-18
SW-15	SW-15-95		GSW-15
SW-16	SW-16-95	SW-9	SW-9
SW-17	SW-17-95	SW-11	SW-11
SW-18	SW-18-95		GSW-18

Each of the 1995 surface water samples was analyzed for miscellaneous parameters, inorganics, and metals (total for unfiltered samples, dissolved for filtered samples).

For this ERC the filtered and unfiltered surface water samples were summarized separately for the Off-Property West Ditch, South Ditch, and Ephemeral Drainage. Additionally, one sample collected in 1996 (So. Ditch Pond) was summarized to evaluate the Central Pond. Samples SW-11, SW-12, and SW-14 were summarized to quantitatively evaluate the South Ditch. Finally, sample SW-18 was used to quantitatively evaluate the Ephemeral Drainage. 1996 "Recent"

In 1996, ten filtered samples (SO. DITCH #1 through SO. DITCH #4 and SO. DITCH POND) were collected. Five of the filtered samples were analyzed for miscellaneous parameters, dissolved metals, and inorganics. The other five samples were analyzed for hexavalent chromium. These samples along with the filtered samples collected in 1995 were not quantitatively evaluated in the ERC. However, they were summarized and qualitatively evaluated.

All surface water sampling locations are shown in Figure 7. Surface water analytical data are summarized in Tables 2, 3, and 4 for unfiltered/recent, unfiltered/historical and filtered/recent data sets, respectively. All of the surface water samples used in the ERC are presented in Tables A2-2 through A2-4 in Attachment 2.

Fifteen surface water background samples (including 1 duplicate) were collected in April 1996. A full description of all background sampling, analysis and interpretation for surface water is presented in Attachment 3. The background surface water sampling locations are identical to the sediment background locations. These locations and surface water background concentrations are presented in Section 4.1 of the Supplemental Phase II Report and in Attachment 3. The 15 surface water background sampling locations are off-property as shown in Figure 6. The median and maximum concentrations for site-specific surface water background analytes are shown in Table A3-2 in Attachment 3. All 15 surface water background samples were analyzed for pesticides. Five samples were analyzed for miscellaneous parameters, metals, pesticides, volatiles (including trimethylpentenes), and semivolatiles.

2.2.3 Sediment

In 1992, two rounds of sampling (a total of 45 samples including two duplicates) were conducted at locations SW-01 through SW-06 and SW-08 through SW-22 (with a duplicate at SW-06, SW-17). Location SW-07 was sampled in only one round during that period. In late 1992 and early 1993, one sampling round (a total of seven samples) was conducted at locations SW-23 through SW-30 (excluding SW-28). Two of these samples were collected upstream of the site, at SW-29 and SW-30; analytical results from SW-30 were identified as local conditions because that sample contained no contaminants indicative of a release at the site.

Sample SW-29 was included in the overall site data set because site-related compounds were detected in that sample; however, sediment samples collected from locations SW-23 through SW-30 were not included in data summaries, as they were collected from the East Ditch which was not evaluated in this ERC.

Sediment samples collected in 1992 and 1993 were analyzed for miscellaneous parameters, inorganics, metals, pesticides and PCBs, volatiles (including trimethylpentenes), and semi-volatiles.

In 1995, one sediment sample (POND) was collected from the Central Pond. This sample was analyzed for miscellaneous parameters, inorganics, metals, pesticides and PCBs, volatiles (including trimethylpentenes), and semivolatiles. A sample was also collected with a designation SED-17,11, which is a composite from two locations. This latter sample is not used in the risk assessment because, as a composite, it does not provide location-specific information.

In 1997, eight sediment samples were collected by ABB-ES to provide analytical data in support of tissue analysis and toxicity testing studies that are part of the ERC. These samples are designated BS005WDX, BS006WDX, BS007WDO (from the West Ditch); BS008SD (South Ditch); BS009PND and BS010PND (from Central Pond); BS011WMD (Wet Meadow); and BS012REF (from an off-property reference location corresponding with sample location 2 in Figure 6). Sample BS012REF was not used here to characterize release of OHM from the site. All 1997 sediment samples were analyzed for inorganics, metals, pesticides, and semivolatiles.

Subsets of the sediment samples were summarized into groups based on the aquatic habitat in which they were collected. Data were summarized for the following aquatic habitats: the Off-Property West Ditch, Central Pond, South Ditch, Ephemeral Drainage, and On-Property West Ditch. Samples of the flocculent, which occurred along the South Ditch (floc f#1 through floc f#5 and floc WF-2) and Off-Property West Ditch (floc RP-2), were summarized and qualitatively evaluated. Samples collected in 1992 (SW14, SW15, SW16, SW17, and SW18) and 1997 (BS007WDO) were summarized to quantitatively evaluate the Off-Property West Ditch. Samples collected in 1995 (POND) and 1997 (BS009PND and BS010PND) were summarized to quantitatively evaluate the Central Pond. Samples collected in 1992 (SW06, SW07, SW08, SW09, SW10, SW11, and SW19) and 1997 (BS008SD and BS011WMD) were summarized to quantitatively evaluate the South Ditch. Samples collected in 1992 (SW20, SW21, and SW22) were summarized to quantitatively evaluate the Ephemeral Drainage. Finally, the On-Property West Ditch was quantitatively evaluated utilizing data collected in 1992 (SW12 and SW13) and 1997 (BS005WDX and BS006WDX).

All sediment sampling locations are shown in Figure 8. Sediment analytical data are summarized in Table 5. All of the sediment samples that were used in the ERC are presented in Table A2-5 in Attachment 2.

Fifteen sediment background samples (including one duplicate) were collected in April 1996. A full description of all background sampling, analysis, and interpretation for sediment is presented in Attachment 3. The background sediment sampling locations and sediment background concentrations are presented in Section 4.1 of the Supplemental Phase II Report. The 15 sediment background sampling locations are off-property as shown in Figure 6. The median and maximum concentrations for site-specific sediment background analytes are shown in Table A3-3 of Attachment 3. All 15 samples were analyzed for metals, pesticides, hexavalent chromium, volatiles (including trimethylpentenes), semivolatiles, and total organic carbon.

2.2.4 Biological Tissue

ABB-ES ecologists conducted a biological sampling program at the Facility in October 1996. This program included collection of small mammals, plants, crayfish, and amphibians (frogs and tadpoles) and chemical analysis of the biological tissue. The purpose of this program was to obtain site-specific information regarding tissue levels in probable prey items, rather than estimating the levels using published bioaccumulation factors which are not site-specific. Because the intent of the tissue sampling was not to obtain tissue data for comparison with tissue data from a reference location, no biological tissue samples were collected from the reference area (with the exception of one crayfish sample). The tissue data set was used in food chain modeling to assess exposures to higher trophic level organisms. The details of this field program are presented in Attachment 1. All biological sampling locations are shown in Figures A1-1 and A1-2 in Attachment 1.

Analytical results are discussed in Attachment 1. Summaries of the SVOCs, pesticides, and inorganics detected in small mammals, plants, macroinvertebrates, amphibians, and earthworms are presented in Tables A1-1 through A1-5.

<u>**Small Mammals**</u>. All of the small mammal samples were analyzed for TCL pesticides, TAL inorganics, and percent lipids. Five of the fifteen small mammal samples collected were analyzed for TCL SVOCs.

<u>Plants</u>. Each of the four plant samples was analyzed for TCL pesticides and TAL inorganics.

<u>Crayfish</u>. All eight crayfish samples collected from the site were analyzed for TCL pesticides, TAL inorganics, and percent lipids. Five of the eight samples were also analyzed for TCL SVOCs. A crayfish sample collected from the reference area was analyzed for TCL pesticides and percent lipids only.

<u>Amphibians</u>. All of the amphibian samples were analyzed for TCL pesticides, TAL inorganics, and percent lipids. Four of the seven amphibian samples were analyzed for TCL SVOCs.

<u>Earthworms</u>. Tissue data for earthworms were not from field collected worms. Rather, earthworm tissue data were obtained by exposing laboratory-reared earthworms to surface soils from the Facility in a 28-day bioaccumulation test, and measuring the tissue concentrations at the end of the test. This was conducted as part of the earthworm toxicity test program described in greater detail in Section 3.2, Ecological Effects Assessment. Three of the surface soil samples collected from the site (BS013WDXX, BS015SDXX, and BS018PNDX) and the one reference sample (BS021WMDX) were selected for the 28-day bioaccumulation tests. The three samples were selected based on results of the chemical analysis of surface soil, as none of the sample locations were identified as toxic to earthworms during the 14-day sub-chronic toxicity test. Following the 28 days of exposure and one day of depuration, earthworms from the three samples were analyzed for TCL SVOCs, TCL pesticides, TAL metals and percent lipids. A summary of the earthworm chemical analysis is presented in Table A1-5 in Attachment 1.

2.3 IDENTIFICATION OF OHM OF POTENTIAL CONCERN

Selection of OHMPC was conducted in a manner consistent with the MCP. In general, all detected analytes have been retained as OHMPCs unless they meet certain criteria that allow them to be excluded form the risk assessment. MADEP guidance (1995a) lists several reasons why an individual chemical may be dropped from the quantitative risk characterization, including:

- The chemicals are laboratory contaminants.
- Reported levels are consistent with "background" and there is no evidence that their presence is related to the disposal at the location.
- Chemicals are present at low frequency of detection and low concentration and have no history of past or current use of the OHM at the site.

The following text presents specific criteria that were used to exclude contaminants from the list of OHMPC consistent with MADEP guidance.

Laboratory Contaminants. CRA identified contaminants whose detection is attributable to laboratory contamination as part of the Comprehensive Site Assessment; this was described in Section 6.1 of the Phase II Field Investigation Report (CRA, 1993). CRA used criteria identified by USEPA (1989). Those analytical results associated with blank contamination less than five times the blank concentration (for common lab contaminants), or ten times the blank concentration (for other contaminants) were considered to be non-detects. Any analyte that was not "detected" in any sample for that medium (after the blank comparison process was completed) was not retained as an OHMPC. Data collected as part of the Supplemental Phase II Site Investigation, including sediment and soil data for samples collected for toxicity tests and biological tissue data, were not validated, and an evaluation of potential laboratory contaminants was not completed.

Background Concentrations. For media and analytes for which site-specific background analyses were available, an analyte was considered to be "consistent with background" if a statistical analysis concludes that site concentrations are less than the site specific background concentration. In this case, a simple comparison of maximum concentrations and median concentrations between site data and background data was conducted. As recommended in the MADEP Guidance for Disposal Site Risk Characterization (MADEP, 1995a), median and maximum values are selected as summary statistics representing measures of central tendency and spread and are used to compare the site-specific data to the background data. The following criteria, specified in Section 2.3.3.2 of the MADEP Guidance for Disposal Site Risk Characterization, was used to evaluate whether the site-specific data are consistent with the background data:

- If both the median and the maximum values for the site data are greater than the corresponding values from the background data, then the site data are not considered to be consistent with background.

- If both the median and maximum values for the site data are equal to or less than the background data, then the site data are considered to be consistent with background.

- If the median of the site data is less than or equal to the median of the background data, and the maximum of the site data is no more than 50% greater than the maximum for the background data, then the site data are considered to be consistent with background.

- If the maximum of the site data is less than or equal to the maximum of the background data, and the median of the site data is no more than 50% greater than the median for the background data, then the site data are considered to be consistent with background.

This type of comparison was used for surface water and sediment, and for ammonia, calcium, potassium, sodium, sulfate and PAHs in soil. However, adequate site-specific background characterization was not available for a number of analytes in soil.

For soil analytes without site-specific background characterization, an analyte was considered to be "consistent with background" if the maximum site concentration is less than the background concentration specified in the MADEP risk assessment guidance (MADEP, 1995a).

A complete description of the sampling, analysis, and interpretation of those results in characterizing background concentrations for the Facility is presented in Attachment 3.

<u>Low Frequency of Detection and Low Concentration</u>. Each analyte detected less than three times for a particular medium was not retained as an OHMPC if the maximum reported concentration of that analyte was less than twice the SQL reported by the laboratory (this is the method detection limit adjusted for dilution and/or moisture content considerations). If one or both of these criteria were not met, "low frequency of detection and low concentration" was not considered applicable.

In this risk assessment, OHMPCs were selected as follows: clearly identified laboratory artifacts were eliminated; the data were sorted by medium; the data were summarized separately for each medium; an OHMPC selection table was prepared for each medium (the OHMPC selection table contains frequency of detection, range of SQLs, range of detected concentrations, arithmetic mean and median concentration, and background screening concentrations); the "background" and "low frequency and low concentration" criteria discussed above were applied to the data in each OHMPC selection table to select OHMPC for each medium.

2.3.1 Surface Soil

Surface soil data from areas having suitable terrestrial habitat were incorporated into the ERC. These include data from grid areas 1, 2, and 3, which are on the western portion of the Facility and include samples collected in the vicinity of the drum storage area, Drum Area A, and SWMU 30. Data from grid area 8, which encompasses much of the Central Drainage area associated with the South Ditch, and from grid area 9, which encompasses the remainder of the Central Wetland area and upland forest area, were also included. In addition, data associated with SWMU 33 were included. Data from samples collected for earthworm toxicity tests were also included.

A summary of these data is presented in Table 1. OHMPC are identified in this table. The following analytes were not retained as OHMPCs: 2,2,4-trimethyl-1-pentene, 2-butanone, 4-methyl-2-pentanone, trichloroethene, 1,2,4-trichlorobenzene, 2-methylphenol, 4-methylphenol, beta-benzene hexachloride (BHC), delta-BHC, endrin aldehyde, endrin ketone, heptachlor, calcium, iron, magnesium, potassium, and sodium.

2.3.2 Surface Water

Surface water data were summarized across the site for purposes of OHMPC selection. Tables 2 and 3 present data summaries for unfiltered historical and recent data, respectively. The available surface water data for the site included filtered and unfiltered data. Filtered data were generally limited to a few inorganic analytes and were not available for all surface water areas being evaluated. Therefore, only unfiltered data were evaluated in the environmental risk characterization. This may overestimate potential risks to some aquatic life for which only the dissolved fraction may be bioavailable.

The following analytes were not retained as OHMPCs in the historical data set: 2-butanone, dibromochloromethane, 1,2,4-trichlorobenzene, 1,4-dichlorobenzene, 4-nitrophenol, benzo(a)pyrene, di-n-butylphthalate, heptachlor epoxide, calcium, manganese, potassium, and sodium.

The following analytes were not retained as OHMPCs in the recent data set: arsenic, calcium, magnesium, potassium, sodium, and zinc.

2.3.3 Sediment

Sediment data were also summarized across the site for purposes of OHMPC selection. This summary is presented in Table 5; OHMPCs are identified in this table. The following analytes were not retained as OHMPCs: 1,1,2,2-tetrachloroethane, 1,1-dichloroethene, 1,2-dichloroethane, 1,2-dichlorothene, 2-butanone, bromodichloromethane, styrene, tetrachloroethene, vinyl chloride, 4-methylphenol, acenaphthylene, anthracene, benzo(a)pyrene, dibenzo(a,h)anthracene, diethylphthalate, dieldrin, gamma-chlordane, arsenic, calcium, hexavalent chromium, iron, magnesium, manganese, potassium, sodium, and thallium.

2.3.4 Biological Tissue

Biological tissue data from samples collected across the site were summarized together. The primary purpose of the tissue data was to provide site-specific tissue concentrations for the food chain model, and therefore OHMPCs were not identified specifically for biota. The OHMPCs identified for surface soil or sediment were considered to be OHMPCs in the terrestrial and semi-aquatic food chain models, respectively.

2.4 IDENTIFICATION OF ECOLOGICAL HABITATS, RECEPTORS, AND EXPOSURE PATHWAYS

Ecological habitats, receptors, and potential exposure pathways are discussed below for aquatic and terrestrial/wetland habitats.

2.4.1 Aquatic Habitat

The aquatic habitat associated with the Facility consists primarily of a network of shallow, man-made ditches which do not support a diverse aquatic community (Figure 4). The South Ditch begins beyond the fence to the west of the Facility and continues in an eastward direction, joining the West Ditch within the property boundary. The South Ditch discharges to the East Ditch, which flows south along the eastern border of the Facility. The East Ditch flows south to Halls Brook, which in turn flows into the Aberjona River. Aquatic habitats at the site include scrub-shrub, forested, and emergent wetlands. A small pond habitat, associated with the South Ditch (Figure 4), referred to as the central pond is also located on the Facility.

The aquatic fauna associated with the ditches and pond are depauperate but include such taxa as crayfish, dragonfly nymphs, amphipods, midge larvae, and frogs (ABB-ES, 1993). A biological survey of the Facility (Wetlands Preservation, Inc., 1993) identified northern leopard frog (*Rana pipiens*) and bullfrog (*R. catesbiana*) as occurring in the ditches and central pond. ABB-ES ecologists have also identified green frog *(Rana clamitans*) as occurring in the pond and ditches. No fish species were identified during a preliminary ecological survey conducted during the Stage I ERA (ABB-ES, 1993) as well as recent surveys conducted in October 1996 by ABB-ES ecologists. It is unlikely that many aquatic receptors, such as fish and sensitive macroinvertebrate taxa (e.g., mayflies, stoneflies), could utilize the ditch habitat even in the absence of the existing contamination. The surface water in these ditches is ephemeral in nature and of insufficient depth to support populations of fish or sensitive macroinvertebrates.

The central pond has an approximately area of 0.2 acres, and is centrally located at the facility. The pond may be hydrologically connected to the South Ditch during periods of high flow via a low point in the berm along the southwest edge of the pond. The bottom of the pond is unconsolidated mud, which is covered with a layer of flocculent material. Submergent vegetation is nearly absent and emergent herbaceous growth is sparse. The edges of the pond are vegetated with shrubs and herbaceous plant species.

2.4.2 Terrestrial Habitat

The northern portion of the property in general is heavily maintained/industrial and provides no significant habitat for ecological receptors. The southern one-third of the property consists of heavily maintained open field over the Calcium Sulfate landfill, and forested upland. The central one-third of the property contains a mix of maintained open field, forested upland, and wetland areas.

The terrestrial habitat associated with the facility consists of upland forest and maintained open fields. Upland forest consists of a mixed hardwood/white pine stand, with white pine, northern red oak, and white ash as dominant species. Potential receptors in the terrestrial habitats include wildlife, plants, and soil invertebrates. Terrestrial wildlife that could potentially be exposed at the Facility includes eastern cottontail (*Sylvilagus floridanus*), woodchuck (*Marmota monax*), red fox (*Vulpes vulpes*), and ground-foraging birds such as American robin (*Turdus migratorius*) and American woodcock (*Scolopax minor*).

The wetland habitat at the facility includes emergent, scrub-shrub, and forested wetland types. Emergent wetlands are primarily located along the western boundary of the site, and scattered small areas associated with the South Ditch drainage. Forested and scrub-shrub wetlands comprise the majority of the wetland habitat at the site. Semi-aquatic wildlife (i.e., those requiring aquatic habitats to supply a portion of their nutritional or shelter requirements) likely include raccoon (*Procyon lotor*), eastern garter snake (*Thamnophis sirtalis sirtalis*) and wading birds such as green heron (*Butorides virescens*).

2.5 CONCEPTUAL MODEL DEVELOPMENT

A conceptual model of the contaminant pathway from the potential source to each group of ecological receptors was developed. The exposure scenarios depicted in the conceptual model consider the source, environmental transport, partitioning of the contaminants between various environmental media, and identification of exposure routes. Figure 9 presents the exposure pathway model for this ERC. Because of the variety of potential ecological receptors and exposure pathways, the ERC focused on the most likely exposure pathways with the highest potential contaminant exposures for each of the selected indicator species or taxa. It was also necessary to focus the assessment on those pathways for which there are adequate data in the literature (pertaining to the receptors, contaminant exposures, and toxicity) for completion of the risk analysis. As indicated in Figure 9, other pathways were qualitatively addressed. This ERC focused on assessing the nature and magnitude of risks to wildlife and other vertebrates that occur at the Facility. Exposure pathways were also evaluated to assess the potential impacts of reduced abundance of prey items on the selected indicator species.

Semi-aquatic wildlife exposure was evaluated in all aquatic habitats associated with the site including the portion of the West Ditch that is located off-property. Although a narrow drainage ditch is located along the railroad tracks adjacent to the eastern boundary of the Facility (i.e., the East Ditch), an evaluation of the habitat conditions associated with this ditch indicates that it does not provide suitable foraging opportunities for semi-aquatic wildlife including the green heron. This ditch, which is culverted approximately 1,000 feet below the southern property boundary and partially lined with rip-rap, provides minimal cover for wildlife and contains few prey items to attract foraging wildlife. Consequently, ecological exposures in this ditch are not considered to be ecologically significant and were not evaluated in this ERC.

Although shallow groundwater discharges into a wetland area associated with Maple Meadow Brook west of the Facility, there is no indication that site-related contamination is discharging into the surface water. Because there is no complete migration pathway to this wetland, it was not evaluated in this ERC.

2.6 IDENTIFICATION OF ENDPOINTS

The endpoints selected for the ERC are listed in Table 6. The endpoints for aquatic receptors and semi-aquatic and terrestrial wildlife are discussed separately. Both measurement and assessment endpoints are identified in Table 6. Assessment endpoints represent the ecological component to be protected, whereas the measurement endpoints approximate or provide a measure of the assessment endpoint.

2.6.1 Aquatic Receptors

The green frog was selected as the aquatic indicator species, meaning that risks to this species are considered representative of risks to aquatic life at the site. The assessment endpoint selected for this receptor evaluates the likelihood that exposure to surface water and sediment could result in a significant reduction in green frog population size (Table 6). Population-level effects to the amphibian species were assessed using the results of laboratory toxicity data as well as literature information and field observations regarding the presence/absence of amphibians. The toxicity test is a Frog Embryo Teratogenesis Assay - Xenopus (FETAX) bioassay, which was conducted using African clawed frog embryos; survival and growth endpoints were evaluated (American Society for Testing and Materials [ASTM], 1991). It is assumed that frog embryos are the most sensitive life stage, and that population-level effects associated with sediment-borne OHMPCs at the Facility most directly relate to a reduction in the survival of this cohort of the population. The toxicity test results were extrapolated to evaluate the assessment endpoint using a simple population projection model. These population estimates are compared to control results to determine the expected population reduction under contaminant stress. A projected reduction in population size of 25 percent or more is considered to represent a significant effect to amphibian species.

2.6.2 Semi-Aquatic and Terrestrial Wildlife Receptors

Maintenance of subpopulations of wildlife within the habitat provided at the Facility is the assessment endpoint selected for semi-aquatic and terrestrial wildlife species. The green heron was selected as an indicator species for semi-aquatic organisms at the Facility. The American woodcock and red fox were selected as indicator species for terrestrial organisms at the Facility. The results of laboratory toxicity studies in the literature that relate the oral dose of a contaminant with an adverse response to reproduction or survival of a test population (avian or mammalian species) were used as a measure of the assessment endpoint. As indicated in Table 6, site-specific prey tissue and environmental media concentrations were used to estimate dietary exposures for the selected indicator wildlife species. Body dose estimates are compared to literature-derived toxicological data to determine the likelihood of population-level impacts to the selected indicator species (i.e., green heron, woodcock, and red fox). The selected indicator receptors are assumed to respond toxicologically similarly to laboratory test species.

A second assessment endpoint evaluated for wildlife in this ERC is the indirect effect of reduced prey availability on wildlife populations at the Olin property. This assessment endpoint was evaluated for the green heron (based on potential population reduction of green frogs) and woodcock (based on potential population reduction of earthworms). The measurement endpoints include adverse effects to growth, development, and survival of frog embryos in the toxicity tests using sediment elutriate; and growth, reproduction or survival of soil invertebrates in the toxicity tests using surface soil. The toxicological results were used to estimate the predicted population size reduction of earthworm or amphibian prey. These toxicological results were incorporated into a simple population model described in Attachment 5, to estimate potential population-level responses for these receptors. These population estimates were compared to control results to determine the expected population reduction under contaminant stress. A projected reduction in available prey biomass and/or abundance of 50 percent or greater is considered a significant reduction in prey availability in both cases.

3.0 ANALYSIS

In the analysis phase, potential ecological exposures and associated ecological effects are characterized.

3.1 EXPOSURE ASSESSMENT

Exposure assessment is the process of estimating or measuring the amount of an ecological OHMPC in environmental media (surface soils, surface water, and sediment) to which an ecological receptor may be exposed via respective exposure routes (e.g., ingestion or direct contact). Indirect exposures associated with consumption of contaminated prey items are also quantitatively evaluated based on the concentrations of OHMPC measured in prey items.

3.1.1 Identification of Receptors and Exposure Pathways

Both aquatic and terrestrial habitats are present where ecological exposures could occur. Figure 10 presents the habitat categories associated with the Facility. Potential exposure pathways were identified for three groups of ecological receptors: (1) aquatic receptors; (2) semi-aquatic wildlife; and (3) terrestrial wildlife. An exposure pathway includes a source of contamination, contaminated media (surface soil, surface water, and/or sediment) and an exposure route (e.g., drinking of contaminated surface water).

Aquatic Habitats

The primary exposure pathway identified for aquatic receptors is direct contact with the surface water and sediment. Aquatic life may also be exposed to contamination in sediment and food items as a result of ingestion; however, these pathways were not evaluated because ingestion toxicity data for aquatic organisms are generally not available. The green frog (*Rana clamitans*) was selected as the indicator species for aquatic receptors. Amphibians are known to occur in areas throughout the site and to be sensitive to a wide range of chemical stressors, and therefore risks for this receptor are assumed to be representative of potential risks to other aquatic life as well.

Exposure pathways for semi-aquatic wildlife include ingestion of surface water and sediment from water bodies at the Facility and ingestion of aquatic organisms. Food items (e.g., invertebrates and plants) may bioconcentrate chemicals in their tissues as a result of exposures to chemicals in environmental media. Exposures related to dermal contact with sediment or surface water were not evaluated because it is assumed that fur, feathers, or chitinous exoskeleton limit the transfer of contaminants across the dermis. There are also insufficient dermal uptake data for ecological receptors. Exposures related to inhalation were not evaluated because this pathway is generally considered an insignificant route of exposure except in atypical situations, such as following a spill or release. The green heron was selected as the semi-aquatic wildlife indicator species. This species is known to occur at the site and is expected to be representative of other semi-aquatic life at the site.

Terrestrial Habitat

The evaluation of potential ecological impacts on the terrestrial portions of the Facility also focuses on wildlife indicator species. As discussed in Subsection 2.2.1, terrestrial exposures have been evaluated only in those areas of the site where exposures are considered likely. The exposure pathways identified for terrestrial plants and soil invertebrates (e.g., earthworms) are direct contact with the surface soils. Terrestrial plants may be exposed to OHMPCs in surface soil via direct contact and root uptake; soil invertebrates may be exposed via direct (dermal) contact and ingestion of soils. The red fox and woodcock are selected as indicator wildlife species for this terrestrial habitat.

Effects on terrestrial plants were not evaluated because there is no evidence that the existing vegetation in this habitat has been impacted by soil contamination.

Information confirming the absence of rare, threatened, or endangered species (as determined in the Stage I ERA) was requested from the appropriate state and federal natural resource agencies including the United States Fish and Wildlife Service (USFWS), the Massachusetts Division of Fisheries and Wildlife (MDFW), Natural Heritage and Endangered Species Program (NHESP). The USFWS concluded that no federally-listed or proposed threatened and endangered species are known to occur in the project area. However, they did indicate that an occasional transient bald eagle (*Haliaeetus leucocephalus*) or peregrine falcon (*Falco peregrinus*) may occur in the project area (USFWS, 1997). It was determined by the NHESP that there are no rare plants or animals, or exemplary natural communities in the area of the site (MADEP, 1997).

3.1.2 Calculation of Exposure Point Concentrations

Exposure Point Concentrations (EPCs) were identified for surface soil, surface water and sediment. EPCs were also identified for biological samples collected at the site. Surface water and sediment EPCs were identified for the On-Property West Ditch, Off-Property West Ditch, South Ditch, Ephemeral Drainage and Central Pond. Surface soil EPCs were identified for all of the habitat areas evaluated within the site, as discussed below.

For a given chemical in a given exposure area, ~~EPCs for contaminants~~ in surface soil, surface water, and sediment were calculated ~~as~~ the arithmetic average of all samples included for that medium. Non-detects were assigned a concentration ~~equal to one~~-half of the SQL. Duplicate samples were averaged and the result treated as one data point in the calculation of the EPC. If the average concentration exceeded the maximum detected concentration (due to elevated SQLs), the maximum concentration was used as the EPC. Individual EPCs for each exposure point for surface soil, surface water and sediment are presented in Tables 7 through 21. EPCs for biological tissue data are presented in Tables 22 through 26.

Surface Soil. For surface soils, an "overall site EPC" was generated via a two-step process. First, an EPC was calculated for each exposure point, and then a surface area-weighted EPC was calculated for each OHMPC.

Five separate surface soil exposure points were identified from within areas which provide suitable terrestrial habitat for ecological receptors. These exposure points consist of portions of the surface soil grid areas 1, 2, 3, 8, and 9. The frequency of exposure at each exposure point is a function of the surface area of the exposure point relative to the remainder of the site. An area-weighted, "overall site EPC" was calculated based on relative surface area represented by each exposure point as shown in Table 7. This area-weighted "overall site EPC" was used as input for calculating surface soil exposures. This does not take into account habitat preferences and differential use of habitats and areas at the site by terrestrial wildlife receptors.

<u>Surface Water and Sediment</u>. For surface water and sediment, there are five separate exposure points identified which may be used by aquatic and semi-aquatic ecological receptors. These include the On-Property West Ditch, Off-Property West Ditch, South Ditch, Ephemeral Drainage, and Central Pond. EPCs were also developed for a sixth ditch-related exposure point, which was the flocculent collected from the South Ditch. The EPCs at each of the surface water and sediment exposure points are shown in Tables 8 through 21. No area weighting of EPCs was conducted for these surface water and sediment exposure points because it is assumed that some individuals or groups of individuals could be exposed at each of the exposure points. It should be noted that in addition to the historical data, there is also a recent data set (post 1994) for metals in surface water. EPCs for the same exposure points were calculated for these recent data.

Average surface water EPCs for aquatic receptors (e.g., amphibians such as the green frog) and semi-aquatic receptors (e.g., the green heron) are assumed to be equal to the arithmetic mean concentrations of the OHMPCs measured in surface water within each of the five exposure points identified above. Average concentrations are intended to represent the most likely concentration of an OHMPC to which an ecological receptor might be exposed.

Average sediment exposure concentrations for aquatic and semi-aquatic receptors are assumed to be equal to the arithmetic mean concentrations of the OHMPCs measured in sediment within each of the six exposure points identified above. Average concentrations are intended to represent the most likely concentration of an OHMPC to which an ecological receptor might be exposed.

Biological Tissue. EPCs were developed for biological tissue samples collected at the site, including plants, amphibians, crayfish, and small mammals. EPCs were also developed for earthworm tissue from the bioaccumulation study conducted using surface soil collected from the site. These EPCs represent OHM concentrations in prey items for the wildlife food chain models. EPCs for each of these prey items are presented in Tables 22 through 26. No area weighting of EPCs was conducted for these exposure points.

3.1.3 Quantification of Exposure for Wildlife - Food Web Model

Attachment 4 contains a discussion of how contaminant exposures were determined for OHMPCs in surface soil, surface water and sediment for representative wildlife species evaluated in the food web model. Dietary exposures to contaminated prey items were estimated using analytical tissue data obtained from either field caught organisms (including small mammals, frogs, crayfish, and plants) or laboratory organisms exposed to site surface soil (earthworms). These site-specific data were utilized to help reduce uncertainties associated with OHM bioavailability and indirect exposures.

A total body dose (TBD) was estimated for each representative wildlife species for each surface soil OHMPC. The model considers exposure concentrations of OHMPCs in prey items, the amount of contaminated media likely to be ingested, the receptor body weight, the rate of food ingestion and the frequency that a particular receptor would likely forage at the Facility (based on typical foraging ranges). Exposure parameters for the selected indicator wildlife species were obtained from literature sources and guidance documents (e.g., USEPA, 1993). A Site Foraging Factor (SFF) was used to account for the frequency of feeding in the site area by estimating the exposure area within the Facility relative to the receptor's feeding range, and by considering the fraction of the year the receptor would be exposed to site-related contaminants. The actual proportion of time spent on-site may vary depending upon the availability of additional habitat in areas surrounding the Facility.

Incidental ingestion of soil or sediment was also considered. For each representative wildlife species, the estimated percentage of soil or sediment in the overall diet was multiplied by the concentration of each OHMPC in either sediment or soil and the food ingestion rate (kg per day) to determine the soil exposure concentration. The estimated percentage of soil or sediment ingested when feeding was based on available literature values.

3.2 ECOLOGICAL EFFECTS ASSESSMENT

In this section, the potential adverse effects to ecological receptors associated with the identified OHMPCs are identified. The methods used for identifying and characterizing ecological effects for aquatic, semi-aquatic, and terrestrial receptors are described in the following subsections.

3.2.1 Aquatic Receptors

Risks to aquatic receptors are evaluated in this ERC based on site-specific toxicity test results and published Reference Toxicity Values (RTVs), each of which are discussed below.

Toxicity Tests

Toxicity tests are one of the methods used to evaluate effects for aquatic receptors in this ERC. Sediment samples were collected from various aquatic habitats at the site to empirically measure sediment toxicity to amphibians. A 96-hour FETAX assay was conducted utilizing an elutriate prepared from sediment samples collected at the Facility and laboratory-reared embryos of the African clawed frog (*Xenopus laevis*), a standard test organism. The objective of the FETAX assay was to evaluate the toxicity of sediment from the drainage ditches and Central Pond to amphibian receptors at the Facility.

FETAX Screening Tests. Eight 96-hour frog embryo toxicity tests were conducted in accordance with the methodology presented in the ASTM Standard Guide for Conducting a FETAX (ASTM,1991). Seven tests were conducted using sediments collected from various areas at the facility (see Figure 10) and one test was conducted using sediments from the reference location (corresponding with sample location 2 in Figure 6). The laboratory also ran a laboratory control test. The seven sediment samples selected for toxicity testing represent the aquatic areas of ecological concern at the Facility; sample locations were selected based on habitat evaluations conducted during site visits, sediment sampling, and information contained in the Screening Level Environmental Risk Assessment (ABB-ES, 1993).

The FETAX tests were conducted by a subcontracted laboratory using a sediment elutriate, prepared by adding one part site sediment to four parts FETAX solution. This mixture was shaken, allowed to settle, and the elutriate was then decanted. Frog embryos were then exposed to the undiluted elutriate, and embryo mortality and malformation was assessed at the end of the exposure duration. Malformations were identified based on the Atlas of Abnormalities (Nieuwkoop and Faber, 1975). Statistical analyses to assess the significance of any differences in survival between either the field collected reference or the laboratory control and the facility samples was performed. Results are presented in Tables 27 and 28 for survival and developmental effects, respectively. The elutriate samples were shipped to an analytical laboratory and analyzed for TCL SVOCs, pesticides, and TAL inorganics.

Statistically significant mortality was observed in three sample locations, when compared to the laboratory control (BS005WDX, BS006WDX, and BS009PND). When compared to the reference location, only two samples had significant mortality (BS005WDX and BS009PND). Significant developmental effects (i.e., malformation) were identified in five sample locations when compared to the laboratory control (BS005WDX, BS006WDX, BS007WD, BS009PND, and BS010WMD). When compared to the reference, there were two sample locations that had significant developmental effects (BS005WDX and BS006WDX).

__FETAX Definitive Tests (Dilution Tests)__. Three 96-hour definitive assays were conducted following the same protocols outlined for the screening test, except that they were performed on a series of diluted elutriate from each location. Three sample locations (BS005WDXX, BS006WDXXX, and BS009PNDXX) were selected, as they showed the most significant results when compared to the reference location and the laboratory control in the FETAX screening test. The definitive assays were conducted using elutriate diluted with FETAX solution; dilutions include 100% (undiluted), 50%, 25%,12.5%, and 6.25%. The definitive test included 2 replicates per treatment (dilution) and contained 15 embryos per replicate. At the termination of the test, embryo mortality and malformation were assessed. A statistical analysis was conducted similar to that done for the screening test. The diluted samples were not chemically analyzed; it is assumed that the concentrations of detected constituents are roughly equivalent to those that would be calculated by applying the dilution factors (i.e., 50%. 25%, 12.5%, and 6.25% of the undiluted concentration). Results are presented in Table 29.

A definitive assay (i.e., serial dilution test) was conducted using samples in which significant mortality was observed in the screening test (BS005WDX, BS006WDX, and BS009PND). The following test endpoints were developed for these samples: LC-50 (median lethal concentration: concentration lethal to 50% of the sample population), EC-50 (median effect concentration; concentration in which effects would be observed in 50% of the sample population), IC-50 and -25 (median inhibition concentration and 25% inhibition concentration; concentration in which normal development would be inhibited by 50% and 25%, respectively), and ANOEC (acute no observed effect concentration). Table 29 summarizes these five endpoints for the three sample locations.

Reference Toxicity Values

RTVs provide another useful measure of potential risks to aquatic life. For this ERC, the primary aquatic receptor evaluated was the green frog. Therefore, published toxicity data relating toxicity of OHMPCs in surface water to frogs and other amphibians were compiled in order to derive surface water RTVs for the green frog. These were obtained from the available literature, and are summarized in Table 30. To supplement this information, a quantitative structure-activity relationship (QSAR) equation developed by Lipnick et al., (1989) was used to estimate Lowest Observed Effect Concentrations (LOECs) for amphibians. Table 31 summarizes RTVs generated using this approach. These were also included in the overall summary of amphibian toxicity data (Table 30).

Toxicity data relating toxicity of OHMPCs in sediment to amphibians are scarce. The primary indication of sediment toxicity is presumed to be the FETAX tests described above. These results provide an empirical indication as to the likely effects of site sediments on embryo-larval stages of amphibians.

3.2.2 Semi-Aquatic and Terrestrial Wildlife Receptors

Risks to semi-aquatic and terrestrial wildlife receptors are evaluated in this ERC based on RTVs. The potential for indirect effects to those receptors from decreased prey abundance is also evaluated, based on the results of the toxicity tests and population models.

RTVs were identified from the literature for each selected wildlife receptor. The RTV relates the dose of an OHMPC in an oral exposure to the likelihood of an adverse effect. RTVs representing dietary ingestion thresholds for lethal and sublethal effects have been identified. Toxicological data for laboratory test species were extrapolated to the indicator wildlife species using a body weight-based scaling equation provided in Opresko et al. (1993). The approach accounts for inter-taxonomic differences in sensitivity associated with variation in metabolic rate, which is believed to relate to an animal's capacity to detoxify contaminants. In addition, application factors were used to adjust toxicological data depending on the nature of the effects reported and how closely they relate to the assessment endpoints. The toxicity data and body-weight-scaled RTVs are included in Attachment 4.

Potential Indirect Impacts from Decreased Prey Abundance

Potential indirect impacts to terrestrial wildlife from decreased prey abundance were evaluated based on the results of toxicity tests and a simple population model. Results of the FETAX tests, described above, were used to evaluate potential indirect impacts to semi-aquatic wildlife from decreased prey abundance. In addition, earthworm toxicity tests were used to evaluate potential indirect impacts to terrestrial wildlife from decreased prey abundance.

Earthworm Toxicity Tests

<u>Earthworm Screening Test</u>. Ten 14-day sub-chronic earthworm toxicity tests were conducted in accordance with the methodology presented in the ASTM Standard Guide for Conducting a Laboratory Soil Toxicity Test with the Lumbricid Earthworm *Eisenia foetida* (ASTM, 1995). These samples included 8 samples collected from the Facility, as well as a reference sample and a laboratory control sample. Each of the site samples and the laboratory control had four replicates which contained 10 earthworms each. The 8 surface soil samples selected for toxicity testing represent the terrestrial areas of ecological concern at the Facility; sample locations were selected based on habitat evaluations conducted during site visits and surface soil sampling and information contained in the Stage I Screening Level Environmental Risk Assessment (ABB-ES, 1993). Earthworm mortality, growth, and health assessments were conducted on test days 7 and 14. At test

termination, mortality and percent weight loss or gain for earthworms exposed to each surface soil sample were determined. Statistical analyses were performed to assess the significance of any differences in survival and growth between the field collected reference or laboratory control and the facility samples. Results are presented in Tables 32 and 33.

No significant mortality was observed in any of the soil samples, as compared to the laboratory control and reference location. Both the laboratory control and reference location had 100% survival.

The surviving individuals in each replicate were weighed, and an average weight was calculated for each of the site samples, reference location, and laboratory control. The average weight of the four replicates for each of the site samples was compared to the laboratory control and reference locations. The results of this comparison indicated a significant difference in average weight in two samples, BS016SMD and BS020WMD. The average weight of earthworms in the sample BS016SMD was significantly lower than the laboratory control and the reference samples. The average weight of earthworms in the sample BS020WMD was significantly lower than earthworms exposed to soils from the reference location.

Earthworm Definitive (Dilution) Test. A definitive earthworm assay was not conducted as no acute toxicity (i.e., mortality) was observed in the screening assay.

Earthworm Chronic Toxicity Test. At the end of the screening assay, on test day 14, cocoons produced during the assay were recovered and counted. These cocoons were utilized to conduct a chronic screening assay to evaluate reproductive effects. Cocoons were counted and placed back in test chambers with the test material and allowed to mature. Cocoon production from worms maintained in site and reference soils was quite low (averaging < 1 cocoon per sample) for all locations except BS013WDX (see Table 34). In contrast, cocoon production in laboratory control soil was adequate.

Because of the low cocoon production, continuation of the chronic test was not considered feasible (i.e., the small number of individuals produced from the cocoons could not have yielded usable survival or growth data), and therefore it was terminated. The low cocoon production in all samples suggests an effect other than chemical (e.g., pH or physical characteristics of the local soils), because cocoon production in the reference sample was also low. This is discussed further in the risk characterization section. The analytical data from soils used in the toxicity test were compared to literature-derived RTVs for soil invertebrates in the risk characterization section. Table 35 contains a summary of these toxicity data.

4.0 RISK CHARACTERIZATION

Potential risks to subpopulations of wildlife and aquatic receptors from exposures to OHMPCs in surface water, sediment and surface soil are characterized in this section. Risks to wildlife associated with food chain exposures are also included.

The conclusions regarding overall risk to ecological receptors are made by considering various lines of evidence from the results of all components of the assessment (i.e., the approach integrates results of physical, biological, toxicological, and modeling studies to draw risk-based conclusions). The components provide measures of risks for different ecological receptors, exposure pathways, and potential adverse effects. As discussed in the MADEP guidance, a qualitative weight-of-evidence approach is employed to integrate multiple measurement endpoints in making conclusions about the risks to the selected indicator organisms.

4.1 RISKS TO AQUATIC RECEPTORS

Risks to amphibians with respect to impacts on population size (or biomass) of these prey taxa were based on a weight-of-evidence evaluation of the following factors:

- results of FETAX toxicity tests relative to reference location
- results of population model to determine if a 25% decrease in abundance is predicted
- field observations (i.e., presence/absence of amphibians)

- concentrations of OHMPCs in surface water and sediment relative to published toxicity data for the OHMPC from laboratory tests using appropriate aquatic species, and
- concentrations of OHMPCs in sediment elutriates relative to measured responses in laboratory toxicity tests (amphibians).

Each of these is discussed below.

4.1.1 FETAX Results

As mentioned in Section 2.6.1, a 25% (or greater) reduction in amphibian population size (as estimated based on laboratory toxicity test data and the population model) is interpreted as presumptive evidence that significant risks to this aquatic component exist.

The FETAX screening results are summarized in Tables 27 and 28 for survival and malformation, respectively. As indicated in Table 27, mortality at two On-Property West Ditch locations (BS005WDX and BS006WDX), as well as one Central Pond location (BS009PND), was significantly elevated above the laboratory control. When compared to the reference location, however, only the On-Property West Ditch locations had significantly elevated mortalities or developmental abnormalities. In addition, a significantly elevated incidence of developmental abnormalities was observed in these samples, as well as in the second Central Pond sample (BS010PND) and a sample from the Off-Property West Ditch area (BS007WDO). It should be noted that for this ERC, percent normal development was calculated as follows:

% Normal Development = $(N_T - N_D - N_M)/N_T * 100$

where

N_T = Total number of test organisms

N_D = Number of organisms that did not survive

N_M = Number of organisms having one or more malformations

Table 36 contains a summary of the results of the FETAX screening tests and the OHMPC concentrations measured in the bulk sediment and elutriate samples used in the tests. The amphibian RTVs are also included in this table for reference. Pesticides are not presented in this table as they were not detected in sediment elutriate. An examination of the analytical data indicates that there is no clear trend in concentrations of any one analyte that corresponds with the observed toxicological response.

A simple linear regression analysis, with concentration as the independent variable and percent survival as the dependent variable, showed very little correlation between concentrations of any of the OHMPC in sediment elutriate and percent survival (see Table 37). Therefore, it was not possible to identify particular OHMPCs associated with the observed results.

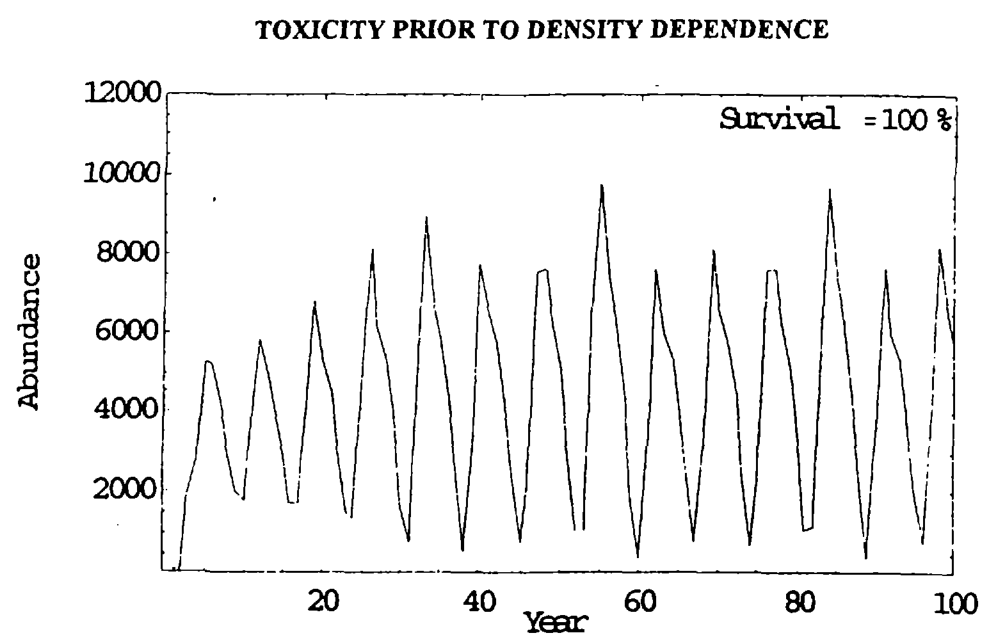
Based on the FETAX screening assay results, acute definitive FETAX assays were conducted at three locations: BS005WDXXX, BS006WDXXX, and BS009PNDXX. The FETAX definitive assay results are summarized in Table 29. Definitive assays are often helpful in identifying concentration-response relationships: as the percent concentration increases, toxicity is expected to increase. Figure 11 contains a graphical presentation of the definitive assay test results, with percent survival shown along the

Y axis and the percent elutriate concentration on the X axis. If a concentration-response relationship exists, the percent survival would be expected to decrease as percent elutriate concentration increases. As shown in Figure 11, percent survival in BS005WDXXX *increased* slightly with increasing elutriate concentration; opposite of the expected response. Percent survival in BS006WDXXX and BS009PNDXX decreased between the 6.25% (most dilute) concentration and 12.5% elutriate concentration. Percent survival did not change appreciably between the 12.5 and 100 percent elutriate concentrations for BSO006WDXXX0. For BS009PNDXX, percent survival peaked at the 25% elutriate concentration, and then decreased between 25%, 50%, and 100% concentrations. The LC_{50}s shown in Table 29 were developed from these results. EC_{50}s and IC_{50}s were developed in a similar manner, based on developmental abnormalities.

4.1.2 Population Model

A simple population model was developed to evaluate population-level impacts from sediment-associated toxicity on amphibians at the Olin Property. The model is described in detail in Attachment 5; the main approach, assumptions, and results are discussed below.

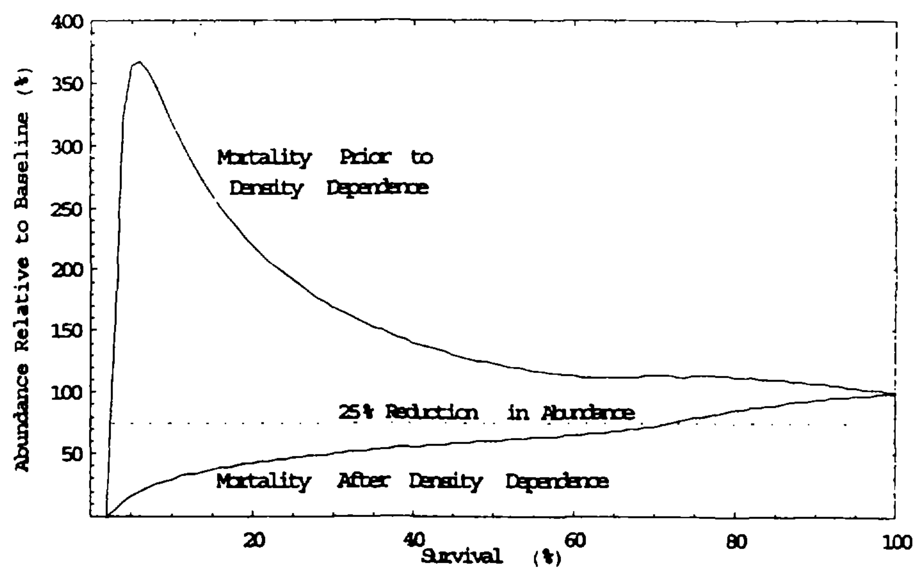
Life history information (e.g., # eggs/year, mortality rates for different age classes) for the green frog was obtained from the literature. This information was used in an age-structured population model, which calculates an estimated population size (i.e., abundance) based on survival and reproductive rates over time. The literature information was used to develop a population abundance under normal conditions:



The fluctuations shown in this simulation are those typically observed under normal conditions. They reflect a lag between production of eggs and development of those eggs into mature adults. Because of the high number of eggs produced per year, if survival was 90-100%, the population would increase exponentially. However, there are limits to the number of frogs an area can support (i.e., its carrying capacity). When the number of eggs/tadpoles exceeds the carrying capacity, there is a high mortality rate due to the resource limitations of an area. This effect is called "density dependence."

The population model was run under two scenarios - one in which toxicity occurs before density dependence, and one in which it occurs after density dependence. Because toxicity is more likely to occur on the egg/embryo-stage of development, it is more likely that the toxicity occurs before density dependence can have an effect.

The results of the population model have been summarized in the following figure:



This figure provides an integrated illustration relating percent survival with population abundance (expressed as a percent of baseline/normal abundance). Assuming that toxicity occurs *before* density dependence, low egg/embryo survival rates (i.e., less than 5% survival, or 95% mortality) would be required in order for the abundance to be reduced by 25% (shown as a dashed line on this figure). Survival rates in samples from the site ranged from 34% (BS006WDXX) to 78% (BS008SDXXX); none were low enough to indicate a 25% reduction in abundance under this more likely scenario.

Use of these survival rates does not take into account decreased survival that might be expected from malformed larvae; therefore, the developmental endpoint was considered in evaluating potential impacts on abundance. As stated previously, percent normal development was calculated as follows:

$$\% \text{ Normal Development} = (N_T - N_D - N_M)/N_T * 100$$

where

N_T = Total number of test organisms

N_D = Number of organisms that did not survive

N_M = Number of organisms having one or more malformations

Therefore, assuming that malformed organisms do not live to maturity, the percent normal development endpoint in the FETAX test is probably a more accurate representation of survival for purposes of the population model.

Table 38 presents the FETAX screening assay results for each location tested, along with a summary of whether or not a 25% reduction in abundance is predicated based on the population model. These results indicate that, assuming toxicity occurs before density dependence, only location BS006WDX (located in the On-Property West Ditch) has a predicted reduction in abundance of greater than 25%.

If toxicity occurs *after* density dependence, survival rates less than 70% might result in a 25% decrease in abundance. An examination of survival rates as reflected by the percent normal development indicates that, under this scenario, a reduction in abundance of greater than 25% is predicted for all locations including the reference location. This could be interpreted to mean that, if toxicity occurs after density dependence, subpopulations at these locations could potentially be significantly affected by constituents present in sediments.

Table 39 contains a similar summary for the FETAX definitive assay and whether or not a 25% reduction in abundance is predicted based on the population model. These results indicate that, assuming toxicity occurs before density dependence, no locations at any dilution (even 100% elutriate) have a predicted reduction in abundance of greater than 25%. If toxicity occurs *after* density dependence, a reduction in abundance of greater than 25% is predicted for all locations at all dilutions.

4.1.3 Presence/Absence Information

A third measurement endpoint in evaluating potential risks to amphibians is the consideration of presence/absence information based on field observations. As discussed in Attachment A1 and indicated in Figure A1-2 within that attachment, seven frog samples were obtained from the site, including four samples from the Central Pond, one from the wet meadow near the South Ditch, and two from the West Ditch. In addition, a review of field notes from various site visits indicates the following notations of amphibians:

<u>Oct. 15, 1992</u>:

1. Presence of bullfrogs near the confluence of the Off-Property West Ditch and On-Property West Ditch,
2. Bullfrogs in South Ditch near SW-7

<u>Sept. 20, 1996</u>:

1. Frog in South Ditch near weir,
2. Frogs from dip net sweep in South Ditch
3. Dip net sweeps in vicinity of stacked haybales - no signs of frogs/crayfish
4. Several frogs in wet meadow northeast of Central Pond.

<u>Sept. 23, 1996</u>:

1. Frog in South Ditch near confluence with East Ditch.

<u>Sept. 24, 1996</u>:

1. No frogs seen in ponded area of Off-Property West Ditch (human access to this area restricted by fencing).
2. Saw several leopard frogs and 1 bullfrog at the Central Pond.
3. Numerous frogs (5-7) seen in small ponded area to northeast of Central Pond.
4. Several frogs noted along path down South Ditch approximately 1/2-way to Central Pond.

<u>Oct. 9, 1996</u>:

1. Leopard frog in marsh at top of On-Property West Ditch.
2. Frog in channelized portion of On-Property West Ditch above confluence of weir. Several frogs noted in this vicinity.

Oct. 10, 1996:

1. Leopard frog in western portion of Central Pond and one tadpole.
2. Whole Central Pond edge was electroshocked with no other amphibians observed.
3. Minnow traps within Central Pond had numerous tadpoles.

Oct. 11, 1996:

1. One frog in emergent marsh section of West Ditch. Two frogs further south of West Ditch.
2. Two frogs in Central Pond; tadpoles in traps.

The above notes include only observations actually noted in the field logbooks. Some were made during site visits for other purposes (i.e., general site reconnaissance, sediment or soil sampling). The majority of these observations were made in autumn; it is expected that amphibians would be more abundant during warmer months. Additional description of frogs observed is included in the Site Habitat Characterization conducted in 1993 (Wetlands Preservation, Inc., 1993).

4.1.4 Comparison of EPCs with Amphibian RTVs

An additional, more traditional method for evaluating risks to aquatic receptors is the comparison of concentrations of OHMPCs in surface water and sediment to RTVs. A hazard quotient (HQ) approach was used in which HQs were calculated for each OHMPC by dividing the estimated EPC by the RTV. Hazard Indices (HIs) were determined by summing the HQs for all OHMPCs. When the estimated exposure concentration is less than the respective RTV (i.e., HQ<1), the contaminant exposure is assumed to fall below the range considered to be associated with adverse effects for growth, reproduction, and survival. This is assumed to be evidence of no significant risk to aquatic life. When the ratio is greater than one (i.e., HQ or HI>1), an evaluation of the analytes and HQs comprising the HI is completed. A discussion of the ecological significance with respect to the assessment endpoints is also included.

Surface Water

Tables 40 through 47 contain comparisons of EPCs for the various surface water data sets with amphibian RTVs described in Subsection 3.2. The results of each of these comparisons are discussed below.

Off-Property West Ditch. The surface water HI for historical data from this location is 170, due primarily to chromium (HQ of 89), ammonia (HQ 29), and aluminum (HQ 27). HQs for di-n-octylphthalate, hexavalent chromium, iron, manganese, and zinc also exceed one. (HQ of 3.1, 89, 7.8, 1.2, and 8.3, respectively.)

The HI for recent surface water data from this location is 4.3, due primarily to iron and ammonia.

On-Property West Ditch. The surface water HI for historical data from this location is 3.8, due primarily to zinc (HQ 1.9). No other HQs exceed one. There are no recent data available for this location.

South Ditch. The surface water HI for historical data from this location is 78, due primarily to ammonia (HQ 20), chromium (HQ 18), di-n-octyl phthalate (HQ 15), and aluminum (HQ 12). HQs for hexavalent chromium, iron, and zinc also exceed one. (HQ of 1.7, 2.1, and 6.2, respectively.)

The HI for recent surface water data from this location is 33, due almost entirely to ammonia (HQ 27). HQs for aluminum and iron also were greater than one (HQ = 2.1 and 1.5, respectively).

Ephemeral Drainage. The surface water HI for historical data from this location is 76, due to di-n-octyl phthalate, aluminum, and iron (HQs of 17, 23, and 26, respectively).

The HI for recent surface water data from this location is 8, due almost entirely to aluminum (HQ = 6).

Central Pond. There are no historical surface water data available from this location. The HI for recent surface water data from this location is 3.0, due primarily to aluminum. HQs for all other analytes were below one.

Sediment

As discussed in subsection 3.2.1, there is a paucity of data relating sediment concentrations with amphibian toxicity. The primary indication of sediment toxicity is presumed to be the results of the FETAX tests coupled with the amphibian population model discussed previously.

4.1.5 Weight of Evidence for Aquatic Receptors

Table 48 presents a summary of findings for aquatic receptors at the site. In Table 49, the findings of the risk evaluation for the green frog are summarized relative to the measurement and assessment endpoints identified during the problem formulation. When considered by themselves, the results of the toxicity tests provide a strong indication of potential risks to aquatic receptors in the On-Property West Ditch. This measurement endpoint is given a medium weight because although it is based on site-specific toxicity tests, the tests themselves relate only to embryo-larval endpoints, and do not directly compare with the assessment endpoint of population-level effects. The results of the population model indicate that a significant reduction in abundance is predicted only for the On-Property West Ditch. This measurement endpoint is given a medium weight because although the population model incorporates both life-history information and toxicity test results to more closely evaluate *population-level* effects, there are uncertainties associated with the use of this model. Field observations of presence/absence of amphibians at the site provide a weak indication of no significant risk; this measurement endpoint is given a high weight because it is based on empirical, site-specific information. The results of the comparison of surface water data versus published amphibian toxicity data provide a weak indication of potential risk at some locations; this measurement endpoint is given a medium-to-low weight. The RTVs used in the comparison were derived from literature values in which test conditions may differ significantly from those present at the site.

The information considered together indicates that a condition of no significant risk does not exist in the On-Property West Ditch, South Ditch, and Ephemeral Drainage area. The primary risk contributors for surface water in the Off-Property West Ditch and South

Ditch for historical data are chromium and ammonia. Di-n-octyl phthalate is also a primary risk contributor for both the South Ditch and Ephemeral Drainage. Consideration of the more recent data, however, demonstrates that HIs under current conditions are considerably lower for the Off-Property West Ditch and the Ephemeral Drainage, and the only remaining risk contributor is ammonia. HIs in the South Ditch are still somewhat elevated, also due primarily to ammonia. Aluminum and iron are also identified as potential risk contributors throughout the site; their background concentrations are also close to or exceed the RTVs for these chemicals. Overall, the On-Property West Ditch and South Ditch appear to be the areas with highest potential risk; therefore, these areas should be the focus of any additional studies/remedial activities at this site.

4.2 RISKS TO SEMI-AQUATIC WILDLIFE RECEPTORS

Potential risks to semi-aquatic receptors (i.e., the green heron) that relate to a reduction in population size were evaluated as follows:

- comparison of predicted dietary exposures, based on measured tissue concentrations in prey items and surface water/sediment ingestion, with RTVs, and
- potential indirect impacts from reduced prey abundance based on results of FETAX assays and frog population modeling.

4.2.1 Risks from Food Chain Exposures

Risks for representative semi-aquatic wildlife species (i.e., the green heron) associated with the ingestion of surface water and sediment and the ingestion of contaminated food were quantitatively evaluated using the HQ approach, calculated by dividing the estimated contaminant exposure concentration or dose by the RTV. HIs were determined by summing the HQs for all OHMPCs. When the HQ is less than 1, the contaminant exposure is assumed to fall below the range considered to be associated with adverse effects for growth, reproduction, and survival, and no significant risk to the wildlife populations is assumed. When the HQ or HI is greater than 1, an evaluation of the analytes and HQs comprising the HI is completed. A discussion of the ecological significance with respect to the assessment endpoints is also included.

For semi-aquatic receptors (the green heron), HIs were calculated for each of the five aquatic habitat areas evaluated (Off-Property West Ditch, On-Property West Ditch, South Ditch, Ephemeral Drainage, and Central Pond). The complete spreadsheets and supporting documentation are presented in Attachment 4. As can be seen in Table 50, the HIs for each area are less than one. HIs for all of these areas were also summed in this table to provide an indication of risks to a receptor feeding across all areas. This HI is also less than one. These results indicate that there does not appear to be a significant risk of harm to the green heron from food chain exposures.

4.2.2 Risks from Indirect Impacts - Reduced Prey Abundance

The likelihood of indirect impacts to semi-aquatic wildlife from reduced prey abundance is evaluated with the assumption that a 50% reduction in abundance of frogs could adversely affect wildlife. Based on the results of the frog population model described above in Subsection 4.1.2 and in Attachment 5, Table 38 indicates that, assuming that toxicity occurs before density dependence, a 50% reduction in abundance of frogs is unlikely for all locations except possibly BS006WDXXX (On-Property West Ditch). The On-

Property West Ditch comprises only a portion of potential habitat for the green heron at the site; the heron is also likely to forage in other aquatic areas at the site. A 50% reduction in abundance at all locations is not indicated, and therefore, indirect effects from reduced prey abundance at the site are unlikely to result in population-level impacts to the green heron and other semi-aquatic receptors.

4.2.3 Weight of Evidence for Semi-Aquatic Receptors

In Table 51, the findings of the risk evaluation for the green heron are summarized relative to the measurement and assessment endpoints identified during the problem formulation. These results indicate no significant risk of harm to the green heron from either direct toxicity via the food chain or indirect effects from reduced prey abundance.

4.3 RISKS TO TERRESTRIAL WILDLIFE RECEPTORS

Risks to terrestrial receptors (i.e., the American woodcock and red fox) that relate to a reduction in population size were evaluated as follows:

- comparison of predicted dietary exposures, based on measured tissue concentrations in prey items and surface soil ingestion, with RTVs, and
- potential indirect impacts from reduced prey abundance based on results of earthworm assays and a comparison of soil EPCs to literature-based earthworm RTVs.

4.3.1 Risks from Food Chain Exposures

Risks for representative terrestrial wildlife species (i.e., the woodcock and red fox) associated with the ingestion of soil and the ingestion of contaminated food were quantitatively evaluated using the HQ approach, calculated by dividing the estimated contaminant exposure concentration or dose by the RTV. HIs were determined by summing the HQs for all OHMPCs.

Food chain exposures for the selected terrestrial receptors were evaluated by considering data from the terrestrial portions across the site. Table 50 includes a summary of the food chain HIs for the woodcock and red fox. Based on this scenario, the HI for the woodcock was 1.9. However, as shown in Table A4-4 in Attachment 4, all OHMPC-specific HQs for this receptor were below 1. The analyte contributing the most to this HI is aluminum, with an HQ of 0.83. The HI for the red fox was less than 1. These results indicate that there does not appear to be a significant risk of harm to terrestrial wildlife from food chain exposures.

4.3.2 Risks from Indirect Impacts - Reduced Prey Abundance

No significant mortality was observed in the earthworm screening toxicity tests. Results of the chronic toxicity tests indicated decreased reproductive capacity in all soil samples from the site as well as that from the reference location. This decreased cocoon production does not appear to be chemical-related, as it was similar at all locations tested across the site, regardless of chemical concentrations in the samples. It is more likely a reflection of differences in the physical characteristics of the local soils (e.g., grain size, percent clay, amount of organic material) relative to those in the laboratory control (formulated soil). To further evaluate potential chemical-related effects, surface soil EPCs were compared to earthworm RTVs from the literature (Table 52). This comparison indicates that chromium concentrations in surface soils from areas with terrestrial habitat could potentially pose a risk to earthworms, based on a HQ of 10; HQs for all other OHMPC were less than 1. An examination of exposure point calculations presented in Table 7 indicates that Area A01 (which includes SWMUs 30 and 33), Area A03 (which includes SWMU 27), and Area A08 have elevated concentrations of chromium which contributed to the area-weighted average of 520 mg/kg. The maximum chromium concentration detected in toxicity test samples was 480 mg/kg. No significant mortality or growth effects were observed in worms exposed to this concentration. Table 53 contains a comparison of concentrations in surface soil samples used in the toxicity tests versus these RTVs. As can be seen in this table, chromium concentrations in the tests having significant growth results were quite low relative to those in which no significant growth results were observed. Although cocoon production was low at all locations including the reference location, chromium concentrations varied from 3.0 to 480 mg/kg. The lack of mortality at any of these concentrations, combined with the low cocoon production at all locations, indicates that the observed effect is not related to OHMPC at the site and does not indicate a 50 percent reduction in abundance of earthworm populations at the site.

4.3.3 Weight of Evidence for Terrestrial Receptors

In Table 54, the findings of the risk evaluation for the woodcock and red fox are summarized relative to the measurement and assessment endpoints identified during the problem formulation. These results support a finding of no significant risk of harm to the woodcock or red fox from either direct toxicity via the food chain or indirect effects from reduced prey abundance.

4.4 COMPARISON OF SITE CONDITIONS TO APPLICABLE OR SUITABLY ANALOGOUS STANDARDS

According to the MCP, a level of no significant risk of harm to the environment has not been achieved if concentrations of OHM exceed any to Applicable or Suitably Analogous Standards (ASASs) at current and reasonably foreseeable exposure points (310 CMR 40.0995(4)d) (MADEP, 1995b). Tables 55 through 62 contain comparisons of EPCs for the various surface water data sets with ASASs, which consist of the Massachusetts Water Quality Standards. Massachusetts Water Quality Standards are applicable to all waters of the State. They are equivalent to the promulgated Federal Ambient Water Quality Criteria for protection of aquatic life and its uses, but *do not* include LOECs included for many chemicals for which criteria could not be established.

Criteria for some inorganic analytes (e.g., cadmium, chromium, copper, lead, nickel, and zinc) are dependent upon water hardness; a site specific water hardness was calculated for unfiltered, historic and recent surface water collected from the property. To calculate the hardness, the detected concentrations of calcium and magnesium were substituted in the equation (Hardness, mg equivalent $CaCO_3$/L = 2.497 [Ca, milligrams per liter (mg/L)] + 4.118 [Mg, mg/L]) presented in the Standard Methods for the Examination of Water and Wastewater (Franson, 1992). The calculated hardness for unfiltered historic and recent surface water was 113 and 234 mg/L, respectively.

The criteria for ammonia are dependent upon temperature and pH; a water temperature of 15°C, and a pH range of 6.5 to 7.5 were assumed. The criteria for ammonia further specify general water body/receptor type (sensitive cold-water species present or absent);

the criteria for waters where salmonids and other sensitive cold-water species are absent were used for these comparisons. The results of these comparisons are discussed below.

Off-Property West Ditch. For historical data, EPCs of aluminum, chromium, hexavalent chromium, lead, copper, iron, and ammonia exceed their respective ASAS concentrations.

For recent data, EPCs of iron, aluminum, and ammonia exceed their respective ASAS concentrations.

On-Property West Ditch. For historical data, the EPC of aluminum exceeds its ASAS concentration. EPCs for all other OHMPC are below their respective ASAS concentrations. There are no recent data available for this location.

South Ditch. For historical data from this location, the EPCs of aluminum, ammonia, chromium, hexavalent chromium, and iron exceed their respective ASAS concentrations.

For recent data, the EPCs of ammonia, aluminum, and iron exceed their respective ASAS concentrations.

Ephemeral Drainage. For historical data from this location, EPCs for aluminum, lead, iron, and mercury exceed their respective ASAS concentrations.

For recent data, the EPCs for aluminum exceeds its ASAS concentration.

Central Pond. There are no historical data available from this location. For recent data from this location, only the EPC of aluminum exceeds its ASAS.

The background concentrations of aluminum and iron exceed their respective ASAS concentrations.

4.5 UNCERTAINTY ANALYSIS

The general uncertainties associated with the ERC are outlined in Table 63. Specific uncertainties in the ERC process for the Facility are identified and discussed in this section. The emphasis of the uncertainty analysis is to discuss the assumptions of the ERC process that may influence the risk characterization results and assessment conclusions. The effects of the uncertainties discussed in this section were incorporated, to the extent possible, in the weight-of-evidence evaluation in the risk characterization.

4.5.1 Exposure Assessment

Only OHMPC identified for soil or sediment were considered to be OHMPC in biota. It is possible, however, that analytes eliminated as OHMPCs in soil or sediment may have been present at concentrations in biota that may have been of concern (i.e., due to bioaccumulation), but they were not included in the food chain analysis. In surface soil, five pesticides were eliminated as OHMPC due to low frequency of detection and low concentration. Of these, four were non-detect in small mammals and plants and three were non-detect in earthworms. This is unlikely to have underestimated risk to wildlife receptors.

Some of the more recent surface water and sediment samples were analyzed only for inorganics. Phthalates (identified as OHMPC in the historical surface water data sets) were risk drivers for aquatic life in the South Ditch and Ephemeral Drainage Area, and therefore current risks to in these water bodies may have been underestimated. The di-n-octylphthalate exposure point concentration in the historical surface water data set for the South Ditch was 0.0049 mg/L, which resulted in an HQ of 15. This could presumably be added to the recent surface water data set HI, which would increase the HI from 32 to 47. It would not change the overall conclusions for the South Ditch. Similarly, the di-n-octylphthalate exposure point concentration in the historical surface water data set for the Ephemeral Drainage Area was 0.0053 mg/L, which resulted in an HQ of 17. Adding this to the recent surface water data set HI would increase it from 76 to 93. It would not change the overall conclusions for the Ephemeral Drainage Area.

An area-weighted average EPC was calculated for OHMPC in surface soil. It was assumed that the samples collected from within a specific grid area are representative of the entire area, when actual concentrations within that area may be higher or lower. This may have underestimated exposure and risk estimates for non-mobile species, but for the majority of wildlife receptors this approach likely has a neutral impact on exposure and risk estimates.

Data collected as part of the Supplemental Phase II Investigation, including biological tissue data and soil, sediment, and sediment elutriate samples used for the toxicity tests, were not validated. This introduces uncertainty into the assessment. However, validation would not typically indicate that there should be additional OHM evaluated nor would it typically increase concentrations. The impact on the risk estimates is likely minimal.

The selected indicator species are assumed to be representative of the types of ecological receptors present at the site. This could potentially underestimate risks if more sensitive species are present at the site than those evaluated. The green frog, which was the aquatic organism selected as an indicator species, is known to occur at the site. Amphibians are known to be sensitive to environmental stressors relative to other aquatic receptors likely to be present at this site; therefore risks to other aquatic receptors present at the site (e.g. salamanders or turtles) are unlikely to have been underestimated. The green heron was selected as the semi-aquatic indicator species, as at least one individual has been known to frequent the site. Herons are likely to receive higher exposures to OHMPC in surface water and sediment relative to other semi-aquatic species (e.g., mallards, muskrats) because of their foraging habits and food preferences. Therefore, risks to other semi-aquatic receptors present at the site are unlikely to have been underestimated. The red fox and woodcock were selected as representative terrestrial receptors. These receptors are likely to receive higher exposures to OHMPC in surface soil relative to other terrestrial receptors because of their foraging habits and food preferences.

Wildlife receptors were assumed to forage equally througout all areas identified as having suitable habitat, when they are actually more likely to forage more in some areas offering better cover or feeding opportunities, and less in others having less appealing habitat or resources. This assumption is unlikely to have a significant effect on the results of this ERC.

Proportion of time spent on-site was estimated using a Site-Foraging Frequency (SFF), which is based on site area relative to the receptor's home range. The actual proportion of time spent on-site may be lower, because of the availability of additional habitat in areas surrounding the Facility. This is particularly true for species such as the heron which can easily move from one area to another and for which additional habitat is available. This may have overestimated risk to the heron.

Earthworm concentrations were assumed to be representative of concentrations present in the invertebrate portion of the diet. This is likely to overestimate exposure, because other invertebrates (e.g., grasshoppers, flying insects), which are also likely to comprise some of the invertebrate portion of the diet, do not live in close association with the soil and are likely to have lower concentrations.

There is uncertainty involved in the population model used to characterize risks to populations of organisms at the site, which may have over- or under-estimated effects to populations. However, the use of this model introduces less uncertainty than calculating risks to individuals and then qualitatively estimating what the population-level impact might be.

LC50s and other values calculated from toxicity tests are typically relied upon in risk assessments to provide an estimate of risk. However, these values may have very little relevance to natural populations, when so many other factors contribute to success or failure of a population.

A projected reduction in population size of 25 percent or more was considered to represent a significant effect to amphibian species, and a projected population of 50 percent or more was considered to represent a significant effect to semi-aquatic species that feed on them. These levels are based on professional judgment but appear to be reasonable, based on the results of two studies discussed below which are summarized in Begon and Mortimer (1986). They reported that studies on population levels of the aquatic invertebrate *Daphnia* sp. showed that harvest of 90 percent of young individuals of this species did not significantly affect the population[1]. Studies on guppies (*Lebistes reticulatus*) demonstrated that harvest of 50 percent of the adult individuals decreased the population, that harvest of 75 percent led to extinction, and harvest of 25 percent did not affect the population (i.e., it resulted in a sustainable harvest).

4.5.2 Effects Assessment

Surface water toxicity benchmark values used to evaluate amphibian exposures are generally limited to studies involving direct contact/ingestion of surface water. The majority of published toxicity studies using amphibians are based on embryo-larval or tadpole stages because they are assumed to be the most susceptible to toxic effects of contaminants. Use of these benchmarks may overestimate risks to adult amphibians that may not be as susceptible.

The FETAX test used elutriate water prepared from sediment collected at the site. Consistent with FETAX standard test protocol, the elutriate mixture was prepared by mixing 1 part sediment with 4 parts FETAX solution, stirring for 30 minutes, allowing sediment to settle, and then decanting off the elutriate.. The aeration from stirring also could have caused volatile constituents present in the sediment to volatilize. Since VOCs are not OHMPC at this site, this is unlikely to have affected the results of the risk assessment.

[1] For purposes of population modeling, harvest is roughly comparable to mortality, as both result in removal of individuals from the population.

The percent malformation in the FETAX laboratory control (8 percent of test organisms) slightly exceeded the ASTM recommended limit of 7 percent. This lends uncertainty to the FETAX results, however, the impact on the results and conclusions is likely to be minimal.

4.5.3 Risk Characterization

The risk assessment results for aquatic receptors are based on an assumption that toxicity occurs before any density-dependent reduction in population size occurs. This is a logical assumption because the organism being tested is the embryo/larval stage, and density dependence would be expected to occur and increase in later stages of development (i.e., after the eggs have hatched and organisms have had an opportunity to begin to deplete the available resources). The risk evaluation for aquatic receptors is based on effects to embyro/larval stage of the frog, and does not take into account any increased mortalities in adult organisms that might result from exposure to OHMPC. This could underestimate potential risks to aquatic receptors.

4.5.4 Applicable or Suitably Analogous Standards

Massachusetts Surface Water Quality Standards, which are considered ASASs, were exceeded, and therefore the MCP states that a condition of no significant risk of harm to the environment has not been achieved. However, these ASASs consist of criteria based on sensitive species such as rainbow trout, and they are not truly appropriate for the types of aquatic receptors that would occur in surface water bodies at this site; risks to aquatic receptors at the site based on these ASASs are likely overestimated.

5.0 SUMMARY AND CONCLUSIONS

This Stage II ERC was conducted to evaluate potential risks to subpopulations of wildlife and aquatic receptors from exposure to OHMPCs in surface water, sediment, surface soil, and biota.

5.1 AQUATIC RECEPTORS

Risks to aquatic receptors (i.e., the green frog) were evaluated based on results of FETAX toxicity tests, results of a population model, field observations, and concentrations of OHMPCs in surface water and sediment elutriate relative to published RTVs. The results of the toxicity tests indicate significant toxicity at two locations in the On-Property West Ditch. The population model, which incorporated the results of the toxicity tests, indicated a greater than 25% reduction in frog subpopulations in the On-Property West Ditch. These results are given greater consideration in the overall weight of evidence evaluation because they are based on site-specific information and a model which directly relates the results of the toxicity tests to a population level effect, which is the selected assessment endpoint. Sediment elutriate concentrations were compared with amphibian RTVs in an attempt to identify chemicals responsible for the toxicity observed in the tests; no trends were noted, and a regression analysis indicated that there is no correlation between any of the OHMPCs and the observed toxicity.

A comparison of surface water concentrations with amphibian RTVs resulted in HIs greater than 1, particularly in the Off-Property West Ditch, South Ditch, and Ephemeral Drainage areas. Chromium, ammonia, and di-n-octylphthalate are risk contributors for historical data.

Concentrations and associated HIs for recent data are considerably lower than historical data in both the Off-Property West Ditch and the Ephemeral Drainage. The primary site-related risk contributor from the more recent data is ammonia. Aluminum and iron are also identified as potential risk contributors. The results of the ERC do not support a conclusion of no significant risk of harm to aquatic receptors.

5.2 SEMI-AQUATIC WILDLIFE RECEPTORS

Risks to semi-aquatic wildlife receptors (i.e., the green heron) associated with exposures to OHMPC were evaluated based on results of a food chain model, which evaluated food chain exposures based on site-specific tissue concentrations for likely prey items (e.g., frogs and crayfish) as well as surface water and sediment ingestion exposures. Results of the model indicated that HIs for each of the ditch areas evaluated are less than one, indicating that there is no significant risk of harm to semi-aquatic receptors from exposure to OHMPCs at the site. Indirect impacts to semi-aquatic wildlife receptors from reduced prey abundance were also evaluated, based on the FETAX toxicity test results which were incorporated into the frog population model. A 50% reduction in abundance is unlikely at all locations except possibly the On-Property West Ditch. This ditch comprises only a portion of potential habitat for the heron at the site, and since a significant reduction in prey items at other areas of the site is not predicted, an overall 50% reduction in abundance is unlikely. The results of the ERC support a conclusion of no significant risk of harm to semi-aquatic wildlife receptors.

5.3 TERRESTRIAL WILDLIFE RECEPTORS

Risks to terrestrial wildlife receptors (i.e., the woodcock and red fox) associated with exposures to OHMPC were evaluated based on results of a food chain model, which incorporated site-specific tissue concentrations for likely prey items (e.g., earthworms and small mammals) as well as incidental ingestion of surface soil. Results of the model indicated that the HI for the fox is below 1, while that for the woodcock is 1.9. All OHMPC-specific HQs for the woodcock were below 1; the analyte contributing the most to this HI is aluminum, with an HQ of 0.83. These results support a conclusion of no significant risk of harm to terrestrial wildlife receptors from exposure to OHMPCs at the site.

Indirect impacts to terrestrial wildlife receptors from reduced prey abundance were also evaluated, based on the earthworm toxicity test results. No significant toxicity was observed in any of the soil samples tested. However, in the chronic earthworm toxicity test, potential reproductive effects were indicated by low cocoon production relative to the laboratory control. Low cocoon production was also noted in the reference location. This low cocoon production does not appear to be chemically related, as it was similar at all locations tested, regardless of chemical concentrations present in the samples used for the tests. Low cocoon production is attributed to a reflection of differences in the physical characteristics of the local soils (grain size, percent clay, amount of organic material) relative to those of the formulated soil used in the laboratory control. The overall results of this evaluation indicate that there is no significant risk of harm to terrestrial wildlife receptors from reduced prey abundance resulting from exposure to OHMPCs at the site.

5.4 COMPARISON TO ASASs

Surface water concentrations of several inorganics, including aluminum, chromium, copper, iron, lead, and ammonia at one or more surface water locations at the site exceed Massachusetts Surface Water Quality Standards, which are considered ASASs. Because these ASASs are exceeded, the MCP states that a condition of no significant risk of harm to the environment has not been achieved. These ASASs consist of criteria which are not truly appropriate for the types of aquatic receptors that would occur in surface water bodies at this site, because they are protective of sensitive cold water fish species such as trout which would not be expected to occur at this site, and they should therefore be given a low overall weight of evidence relative to the other findings of this ERC.

5.5 CONCLUSIONS

The results of the ERC support a finding of no significant risk of harm to terrestrial and semi-aquatic receptors at the Olin Wilmington Facility. However, for aquatic receptors a condition of no significant risk of harm to the environment does not exist. Future studies or remedial actions should focus on addressing sediment-related risks in the On-Property West Ditch (i.e., a Tier 1 Toxicity Identification Evaluation [TIE]), and potential surface water-related risks in the Off-Property West Ditch, South Ditch, and Ephemeral Drainage areas.

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TABLE 1
IDENTIFICATION OF ECOLOGICAL OHM OF POTENTIAL CONCERN - SURFACE SOIL

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

OHM	Site Data/Concentration [1] Minimum SQL	Maximum SQL	Frequency of Detection	Minimum	Maximum	Arithmetic Mean	Median	Background Concentration [2] Median	Maximum	OHM of Potential Concern? [3]	Reason [4]
VOCs (mg/Kg)											
1,1,1-Trichloroethane	0.005 :	0.016	15 / 39	0.002	0.23	0.0135	0.007	NB		Yes	
1,1-Dichloroethene	0.005 :	0.016	1 / 39	0.018	0.018	0.004	0.007	NB		Yes	
2,4,4-Trimethyl-1-pentene	0.005 :	0.3	5 / 39	0.0008	0.014	0.0085	0.007	NB		Yes	
2,4,4-Trimethyl-2-Pentene	0.005 :	0.039	2 / 39	0.001	0.005	0.0047	0.007	NB		No	FC
2-Butanone (MEK)	0.011 :	0.05	2 / 39	0.001	0.004	0.008	0.013	NB		No	FC
4-Methyl-2-Pentanone (MIBK)	0.011 :	0.05	1 / 39	0.007	0.007	0.0081	0.013	NB		No	FC
Acetone	0.013 :	0.025	29 / 39	0.005	0.093	0.0202	0.016	NB		Yes	
Methylene Chloride	0.005 :	0.041	13 / 39	0.002	0.047	0.0073	0.007	NB		Yes	
Tetrachloroethene (PCE)	0.005 :	0.014	3 / 39	0.001	0.073	0.0052	0.007	NB		Yes	
Toluene	0.005 :	0.013	8 / 39	0.0006	0.015	0.0039	0.006	NB		Yes	
Trichloroethene (TCE)	0.005 :	0.016	2 / 39	0.007	0.009	0.0039	0.007	NB		No	FC
SVOCs (mg/Kg)											
1,2,4-Trichlorobenzene	0.38 :	160	1 / 35	0.25	0.25	3.1739	0.58	ND		No	FC
2-Methylnaphthalene	0.38 :	32	3 / 35	0.007	560	16.9274	0.58	ND		Yes	
2-Methylphenol (o-Cresol)	0.39 :	160	2 / 35	0.02	0.049	3.2184	0.61	ND		No	FC
4-Methylphenol(p-Cresol)	0.39 :	160	1 / 35	0.34	0.34	3.2324	0.61	ND		No	FC
Acenaphthene	0.38 :	32	1 / 35	170	170	5.7996	0.61	ND		Yes	
Acenaphthylene	0.38 :	32	4 / 35	0.008	420	12.9224	0.58	ND		Yes	
Anthracene	0.39 :	32	9 / 35	0.002	290	9.0954	0.52	ND		Yes	
Benzo(a)Anthracene	0.39 :	32	10 / 35	0.008	140	4.8747	0.5	ND		Yes	
Benzo(a)Pyrene	0.38 :	32	7 / 35	0.011	100	3.745	0.5	ND		Yes	
Benzo(b)Fluoranthene	0.38 :	32	9 / 35	0.01	44	2.1424	0.5	0.06	0.062	Yes	
Benzo(g,h,i)Perylene	0.38 :	32	2 / 35	0.03	29	1.7656	0.61	ND		Yes	
Benzo(k)Fluoranthene	0.38 :	32	9 / 35	0.006	66	2.7609	0.5	ND		Yes	
Benzoic Acid	1.9 :	770	13 / 35	0.039	1.8	15.0234	2.1	ND		Yes	
Butylbenzylphthalate	0.38 :	160	2 / 34	0.8	2.6	3.3363	0.61	ND		Yes	
Chrysene	0.39 :	32	10 / 35	0.012	150	5.1675	0.5	ND		Yes	
Di-n-butylphthalate	0.44 :	160	23 / 34	0.013	10	2.8484	0.074	ND		Yes	
Di-n-octylphthalate	0.38 :	160	3 / 34	0.012	4.7	3.3736	0.58	ND		Yes	
Dibenzofuran	0.38 :	32	1 / 35	39	39	2.0567	0.61	ND		Yes	
Diethylphthalate	0.38 :	160	12 / 35	0.01	0.085	3.0753	0.5	ND		Yes	
Fluoranthene	0.39 :	32	16 / 35	0.008	410	12.4855	0.42	0.057	0.066	Yes	
Fluorene	0.38 :	32	2 / 35	0.008	430	13.2221	0.61	ND		Yes	
Indeno (1,2,3-cd)Pyrene	0.38 :	32	6 / 35	0.031	24	1.5751	0.5	ND		Yes	
N-Nitrosodiphenylamine (1)	0.39 :	160	7 / 33	0.075	32	3.7979	0.555	ND		Yes	
Naphthalene	0.39 :	32	4 / 34	0.008	530	16.5236	0.57	ND		Yes	
Phenanthrene	0.39 :	32	15 / 34	0.011	1000	30.139	0.42	0.043	0.043	Yes	
Phenol	0.39 :	160	1 / 34	2.4	2.4	3.3719	0.62	ND		Yes	

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STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

OHM	Site Data/Concentration [1] Minimum SQL	Maximum SQL	Frequency of Detection	Minimum	Maximum	Arithmetic Mean	Median	Background Concentration [2] Median	Maximum	OHM of Potential Concern? [3]	Reason [4]
Pyrene	0.39 :	32	17 / 34	0.011	320	10.1249	0.39	0.056	0.065	Yes	
bis(2-EthylHexyl)phthalate	0.43 :	160	29 / 34	0.0655	5500	175.7294	0.54	ND		Yes	
Pesticides/PCBs (mg/Kg)											
4,4'-DDD	0.0038 :	0.1	10 / 36	0.0001	0.017	0.0088	0.0051	NB		Yes	
4,4'-DDE	0.0038 :	0.1	17 / 36	0.0005	0.011	0.0086	0.004	NB		Yes	
4,4'-DDT	0.0038 :	0.1	20 / 36	0.0014	1.7	0.0582	0.0062	NB		Yes	
Aldrin	0.002 :	0.052	4 / 36	0.0001	0.0019	0.0043	0.0025	NB		Yes	
Alpha-BHC	0.002 :	0.052	5 / 36	0.0002	0.22	0.0099	0.0027	NB		Yes	
Alpha-Chlordane	0.002 :	0.27	5 / 36	0.0002	0.052	0.025	0.0028	NB		Yes	
Beta-BHC	0.002 :	0.052	1 / 36	0.0001	0.0001	0.0044	0.0028	NB		No	FC
Delta-BHC	0.002 :	0.052	1 / 36	0.0015	0.0015	0.0044	0.0027	NB		No	FC
Dieldrin	0.0038 :	0.1	12 / 36	0.0004	0.012	0.0082	0.005	NB		Yes	
Endosulfan I	0.002 :	0.052	3 / 36	0.0019	0.099	0.007	0.0026	NB		Yes	
Endosulfan II	0.0038 :	0.1	2 / 36	0.092	0.34	0.0194	0.0054	NB		Yes	
Endrin Aldehyde	0.0038 :	0.1	1 / 36	0.0006	0.0006	0.0071	0.0054	NB		No	FC
Endrin Ketone	0.0038 :	0.065	2 / 36	0.0014	0.0031	0.0073	0.0051	NB		No	FC
Gamma-BHC (Lindane)	0.002 :	0.1	12 / 36	0.0001	0.17	0.0123	0.0029	NB		Yes	
Gamma-Chlordane	0.002 :	0.26	3 / 36	0.0003	0.0052	0.0178	0.0028	NB		Yes	
Heptachlor	0.002 :	0.52	2 / 36	0.0003	0.0004	0.0167	0.0026	NB		No	FC
Heptachlor Epoxide	0.002 :	0.052	3 / 36	0.0001	0.0004	0.0043	0.0028	NB		Yes	
PCB-1016	0.18 :	0.27	1 / 8	0.98	0.98	0.2231	0.24	NB		Yes	
Metals (mg/Kg)											
Aluminum			23 / 23	1700	59000	7150.8696	4930	7000	7900	Yes	
Antimony	0.97 :	22	5 / 23	1.2	79	11.7394	1.3	NA	1.4	Yes	
Arsenic	0.9 :	1.6	21 / 23	1.2	24.5	7.4413	4.7	6.7	7.1	Yes	
Barium			23 / 23	3.6	47	16.7739	13.9	17	22	Yes	
Beryllium	0.18 :	1.6	1 / 23	4	4	0.4804	0.26	NA	0.4	Yes	
Cadmium	0.18 :	1.1	1 / 23	5.8	5.8	0.4848	0.26	NA	2	Yes	
Calcium			23 / 23	61.1	53000	3807.4609	470	620	2000	No	C
Chromium			36 / 36	2.6	5000	543.4806	24	15	16	Yes	
Cobalt	0.21 :	1.5	20 / 23	0.42	45	3.6972	1.4	3.1	3.7	Yes	
Copper			23 / 23	1.1	35	9.6522	6.2	5.8	6.4	Yes	
Cyanide	2 :	2	2 / 8	5.2	7.5	2.3375	2	ND		Yes	
Iron			23 / 23	1200	100000	10516.522	5500	11000	12000	No	C
Lead			23 / 23	2	210	33.887	18.6	10.5	11	Yes	
Magnesium			23 / 23	16.4	1210	574.7565	550	2700	3000	No	B,C
Manganese			23 / 23	1.7	530	56.287	27.7	125	150	Yes	
Mercury	0.089 :	0.18	12 / 23	0.09	3.2	0.3792	0.14	ND	0.3	Yes	
Nickel			23 / 23	0.96	67	7.1287	4	6	6.5	Yes	

TABLE 1
IDENTIFICATION OF ECOLOGICAL OHM OF POTENTIAL CONCERN - SURFACE SOIL

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

OHM	Site Data/Concentration [1] Minimum SQL	Maximum SQL	Frequency of Detection	Minimum	Maximum	Arithmetic Mean	Median	Background Concentration [2] Median	Maximum	OHM of Potential Concern? [3]	Reason [4]
Potassium			23 / 23	46.3	520	192.813	148	260	1400	No	B,C
Selenium	0.5 :	5.1	7 / 23	0.51	2.2	0.757	0.97	ND	0.5	Yes	
Sodium			23 / 23	32	680	114.3304	70.6	29	130	No	C
Thallium	0.5 :	2.3	3 / 23	0.8	1.4	0.7548	1.6	ND	0.6	Yes	
Vanadium			23 / 23	4.3	37	14.7565	14.5	14	16	Yes	
Zinc			23 / 23	4.8	180	28.2087	14.9	19	21	Yes	
Inorganics (mg/Kg)											
Chloride	40 :	40	6 / 8	49	560	141.625	62	NA		Yes	
Nitrogen, Ammonia			28 / 28	15.65	670	176.0446	153.5	26	37	Yes	
Sulfate as SO4	130 :	430	26 / 28	4.2	28000	5084.8643	305	40	30	Yes	

Notes:
1 Samples included in Site Data set are presented in "Data Used in Risk Assessment" Attachment.
Duplicate samples were averaged with their original samples prior to calculation of statistics.
The arithmetic mean represents the arithmetic average of all sample results, with one-half the reporting limit used as the value for non-detects.
The median represents the median value of all sample results, including non-detects, with the reporting limit used as the value for non-detects.
2 The background data set is presented in Section 4.1 of the Phase II Report and in Attachment "Background Characterization".
For OHM with site-specific background data, the maximum detected concentration in the background data set and the median concentration are reported.
The median concentration represents the median of all samples in the background data set, with the reporting limit used as the value for non-detects.
For OHM without site-specific background data, the MADEP Background Soil Concentration is reported as the maximum background concentration (MADEP, 1995)
3 OHM of Potential Concern are OHM that are inconsistent with background conditions and not detected at a low frequency and low concentration.
4 Reason for exclusion as OHM of Potential Concern:
B = Background; the concentration of OHM in the site data is consistent with the concentration of OHM in the background data, as determined by the following criteria (MADEP, 1995):
(1) For OHM without site-specific background data, the maximum detected site concentration is less than or equal to the MADEP background soil concentration.
(2) For OHM with site-specific background data: (a) the maximum detected site concentration is less than or equal to the maximum site-specific background concentration, and the median site concentration is not more than 50% greater than the median site-specific background concentration; (b) the median site concentration is less than or equal to the median site-specific background concentration and the maximum detected site concentration is not more than 50% greater than the maximum site-specific background concentration; (c) both the maximum and median site concentrations are equal to or less than the maximum and median site-specific background concentrations, respectively.
C = Calcium, iron, magnesium, potassium, and sodium were not considered to be OHM, as they are essential nutrients.
FC = Low Frequency and Concentration; the OHM was not detected in more than two samples and the maximum detected concentration was not more than two times the minimum SQL.
OHM = Oil or Hazardous Material
SQL = Sample Quantitation Limit
NB = Not judged to be a background analyte (see background discussion).
ND = Not detected in background data set.
NA = Not Available/Not Applicable
MADEP (1995): Guidance for Disposal Site Risk Characterization - In Support of the Massachusetts Contingency Plan (WSC/ORS-95-141, July).

TABLE 2
IDENTIFICATION OF ECOLOGICAL OHM OF POTENTIAL CONCERN - SURFACE WATER (UNFILTERED, RECENT DATA)

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

OHM	Site Data/Concentration [1] Minimum SQL	Maximum SQL	Frequency of Detection	Minimum	Maximum	Arithmetic Mean	Median	Background Concentration [2] Median	Maximum	OHM of Potential Concern? [3]	Reason [4]
Metals (mg/L)											
Aluminum	0.1 :	0.1	7 / 8	0.11	2.4	0.7813	0.56	0.1	0.37	Yes	
Arsenic	0.005 :	0.008	1 / 8	0.01	0.01	0.0036	0.005	ND		No	FC
Barium			8 / 8	0.01	0.038	0.0216	0.0195	0.018	0.034	Yes	
Calcium			8 / 8	7.3	280	88.35	49.5	18	28	No	C
Chromium	0.015 :	0.015	3 / 8	0.0195	0.023	0.0125	0.015	ND		Yes	
Trivalent Chromium	0.015 :	0.015	2 / 7	0.0195	0.023	0.0114	0.015	ND		Yes	
Iron	0.37 :	0.53	6 / 8	0.082	5.6	1.5715	0.645	0.235	1.8	Yes	
Magnesium			8 / 8	0.91	6.3	3.4138	2.9	2.7	3.4	No	C
Manganese			8 / 8	0.014	0.775	0.3609	0.36	0.042	0.1	Yes	
Potassium	3 :	3	7 / 8	1.1	4.8	2.5	2.5	2.4	3.3	No	C
Sodium			8 / 8	16	130	68.75	61.5	44	58	No	C
Zinc			1 / 1	0.025	0.025	0.025	0.025	0.025	0.048	No	B
Inorganics (mg/L)											
Chloride			8 / 8	24	160	76.625	75	71	110	Yes	
Nitrate & Nitrite as N			1 / 1	6.8	6.8	6.8	6.8	NB		Yes	
Nitrate as N	0.05 :	0.05	6 / 7	0.25	7.2	2.2321	0.7	NB		Yes	
Nitrogen, Ammonia	0.05 :	0.05	6 / 7	0.1	91	27.1321	6.8	ND		Yes	
Sulfate as SO4			8 / 8	25	1100	347.375	205	21	24	Yes	
Sulfide	1 :	1	3 / 7	2	5	1.25	1	NB		Yes	

Notes:

1 Samples included in Site Data set are presented in "Data Used in Risk Assessment" Attachment.
Duplicate samples were averaged with their original samples prior to calculation of statistics.
The arithmetic mean represents the arithmetic average of all sample results, with one-half the reporting limit used as the value for non-detects.
The median represents the median value of all sample results, including non-detects, with the reporting limit used as the value for non-detects.

2 The background data set is presented in Section 4.1 of the Phase II Report and in Attachment "Background Characterization".
For OHM with site-specific background data, the maximum detected concentration in the background data set and the median concentration are reported.
The median concentration represents the median of all samples in the background data set, with the reporting limit used as the value for non-detects.

3 OHM of Potential Concern are OHM that are inconsistent with background conditions and not detected at a low frequency and low concentration.

4 Reason for exclusion as OHM of Potential Concern:
B = Background; the concentration of OHM in the site data is consistent with the concentration of OHM in the background data, as determined by the following criteria (MADEP, 1995):
(1) For OHM with site-specific background data: (a) the maximum detected site concentration is less than or equal to the maximum site-specific background concentration, and the median site concentration is not more than 50% greater than the median site-specific background concentration; (b) the median site concentration is less than or equal to the median site-specific background concentration and the maximum detected site concentration is not more than 50% greater than the maximum site-specific background concentration; (c) both the maximum and median site concentrations are equal to or less than

TABLE 2
IDENTIFICATION OF ECOLOGICAL OHM OF POTENTIAL CONCERN - SURFACE WATER (UNFILTERED, RECENT DATA)

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

	Site Data/Concentration [1]							Background Concentration [2]		OHM of Potential	
	Minimum	Maximum	Frequency of			Arithmetic					
OHM	SQL	SQL	Detection	Minimum	Maximum	Mean	Median	Median	Maximum	Concern? [3]	Reason [4]

the maximum and median site-specific background concentrations, respectively.

C = Calcium, magnesium, potassium, and sodium were not considered to be OHM, as they are essential nutrients.

FC = Low Frequency and Concentration; the OHM was not detected in more than two samples and the maximum detected concentration was not more than two times the minimum SQL.

OHM = Oil or Hazardous Material

SQL = Sample Quantitation Limit

NB = Not judged to be a background analyte (see background discussion).

ND = Not detected in background data set.

NA = Not Available/Not Applicable

MADEP (1995): Guidance for Disposal Site Risk Characterization - In Support of the Massachusetts Contingency Plan (WSC/ORS-95-141, July).

TABLE 3
IDENTIFICATION OF ECOLOGICAL OHM OF POTENTIAL CONCERN - SURFACE WATER (UNFILTERED, HISTORICAL DATA)

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

OHM	Site Data/Concentration [1]							Background Concentration [2]		OHM of Potential Concern? [3]	Reason [4]
	Minimum SQL	Maximum SQL	Frequency of Detection	Minimum	Maximum	Arithmetic Mean	Median	Median	Maximum		
VOCs (mg/L)											
2,4,4-Trimethyl-1-pentene	0.01 :	0.01	8 / 17	0.0035	0.2	0.0187	0.01	ND		Yes	
2,4,4-Trimethyl-2-Pentene	0.01 :	0.01	7 / 17	0.002	0.081	0.0092	0.01	ND		Yes	
2-Butanone (MEK)	0.015 :	0.015	1 / 17	0.018	0.018	0.0078	0.015	ND		No	FC
Acetone	0.015 :	0.015	1 / 17	0.093	0.093	0.01	0.015	ND		Yes	
Bromoform	0.005 :	0.005	5 / 17	0.001	0.003	0.0023	0.005	ND		Yes	
Dibromochloromethane	0.005 :	0.005	1 / 17	0.001	0.001	0.0025	0.005	ND		No	FC
SVOCs (mg/L)											
1,2,4-Trichlorobenzene	0.01 :	0.01	1 / 17	0.002	0.002	0.0048	0.01	ND		No	FC
1,4-Dichlorobenzene	0.01 :	0.01	1 / 17	0.002	0.002	0.0048	0.01	ND		No	FC
4-Nitrophenol	0.025 :	0.025	2 / 17	0.0025	0.003	0.0114	0.025	ND		No	FC
Benzo(a)Pyrene	0.01 :	0.01	1 / 17	0.001	0.001	0.0048	0.01	ND		No	FC
Di-n-butylphthalate	0.01 :	0.01	1 / 17	0.001	0.001	0.0048	0.01	ND		No	FC
Di-n-octylphthalate	0.01 :	0.01	4 / 17	0.001	0.0085	0.0048	0.01	ND		Yes	
N-Nitrosodiphenylamine (1)	0.01 :	0.01	8 / 17	0.002	0.031	0.0055	0.01	ND		Yes	
Phenol	0.01 :	0.01	5 / 17	0.001	0.003	0.0042	0.01	ND		Yes	
bis(2-EthylHexyl)phthalate	0.01 :	0.17	8 / 17	0.002	0.02	0.0139	0.01	ND		Yes	
Pesticides/PCBs (mg/L)											
Heptachlor Epoxide	0.0001 :	0.0001	1 / 17	0.0002	0.0002	0.0001	0.0001	ND		No	FC
Metals (mg/L)											
Aluminum	0.1 :	0.1	16 / 17	0.17	34	6.9147	3.25	0.1	0.37	Yes	
Arsenic	0.005 :	0.005	3 / 17	0.005	0.25	0.0178	0.005	ND		Yes	
Barium			17 / 17	0.007	0.055	0.0242	0.021	0.018	0.034	Yes	
Calcium			17 / 17	4	140	35.9941	30	18	28	No	C
Chromium	0.015 :	0.015	12 / 17	0.032	9.9	1.0167	0.13	ND		Yes	
Cobalt	0.015 :	0.015	5 / 17	0.016	0.11	0.0178	0.015	ND		Yes	
Copper	0.025 :	0.025	1 / 17	0.12	0.12	0.0188	0.025	ND		Yes	
Hexavalent Chromium	0.015 :	0.015	3 / 4	0.0305	0.2	0.078	0.0523	ND		Yes	
Iron			17 / 17	0.048	72	7.6946	2.2	0.235	1.8	Yes	
Lead	0.005 :	0.005	2 / 17	0.015	0.18	0.0137	0.005	ND		Yes	
Magnesium			17 / 17	1.8	17	5.5824	5.6	2.7	3.4	No	C
Manganese			17 / 17	0.013	4.4	0.9965	0.76	0.042	0.1	Yes	
Mercury	0.0002 :	0.0002	1 / 17	0.0009	0.0009	0.0002	0.0002	ND		Yes	
Nickel	0.04 :	0.04	2 / 17	0.049	0.11	0.027	0.04	ND		Yes	
Potassium			17 / 17	0.45	3.7	2.0865	2.4	2.4	3.3	No	BC
Sodium			17 / 17	7	260	124	130	44	58	No	C
Vanadium	0.025 :	0.025	1 / 17	0.19	0.19	0.0229	0.025	ND		Yes	
Zinc	0.025 :	0.025	14 / 17	0.026	0.19	0.0652	0.061	0.025	0.048	Yes	

TABLE 3
IDENTIFICATION OF ECOLOGICAL OHM OF POTENTIAL CONCERN - SURFACE WATER (UNFILTERED, HISTORICAL DATA)

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

OHM	Site Data/Concentration [1] Minimum SQL	Maximum SQL	Frequency of Detection	Minimum	Maximum	Arithmetic Mean	Median	Background Concentration [2] Median	Maximum	OHM of Potential Concern? [3]	Reason [4]
Inorganics (mg/L)											
Chloride			17 / 17	13	260	127.7647	140	71	110	Yes	
Nitrate as N			5 / 5	0.2	6.6	4.05	5.85	NB		Yes	
Nitrite as N	0.05 :	0.05	3 / 5	0.054	0.331	0.104	0.054	NB		Yes	
Nitrogen, Ammonia	0.1 :	0.1	15 / 17	0.26	110	37.0441	43	ND		Yes	
Sulfate as SO4			17 / 17	76	830	328.6471	330	21	24	Yes	

Notes:
1 Samples included in Site Data set are presented in "Data Used in Risk Assessment" Attachment.
Duplicate samples were averaged with their original samples prior to calculation of statistics.
The arithmetic mean represents the arithmetic average of all sample results, with one-half the reporting limit used as the value for non-detects.
The median represents the median value of all sample results, including non-detects, with the reporting limit used as the value for non-detects.
2 The background data set is presented in Section 4.1 of the Phase II Report and in Attachment "Background Characterization".
For OHM with site-specific background data, the maximum detected concentration in the background data set and the median concentration are reported.
The median concentration represents the median of all samples in the background data set, with the reporting limit used as the value for non-detects.
3 OHM of Potential Concern are OHM that are inconsistent with background conditions and not detected at a low frequency and low concentration.
4 Reason for exclusion as OHM of Potential Concern:
B = Background; the concentration of OHM in the site data is consistent with the concentration of OHM in the background data, as determined by the following criteria (MADEP, 1995):
(1) For OHM with site-specific background data: (a) the maximum detected site concentration is less than or equal to the maximum site-specific background concentration, and the median site concentration is not more than 50% greater than the median site-specific background concentration; (b) the median site concentration is less than or equal to the median site-specific background concentration and the maximum detected site concentration is not more than 50% greater than the maximum site-specific background concentration; (c) both the maximum and median site concentrations are equal to or less than the maximum and median site-specific background concentrations, respectively.
C = Calcium, magnesium, potassium, and sodium were not considered to be OHM, as they are essential nutrients.
FC = Low Frequency and Concentration; the OHM was not detected in more than two samples and the maximum detected concentration was not more than two times the minimum SQL.
OHM = Oil or Hazardous Material
SQL = Sample Quantitation Limit
NB = Not judged to be a background analyte (see background discussion).
ND = Not detected in background data set.
NA = Not Available/Not Applicable
MADEP (1995): Guidance for Disposal Site Risk Characterization - In Support of the Massachusetts Contingency Plan (WSC/ORS-95-141, July).

TABLE 4
IDENTIFICATION OF ECOLOGICAL OHM OF POTENTIAL CONCERN - SURFACE WATER (FILTERED, RECENT DATA)

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

	Site Data/Concentration [1]							Background Concentration [2]			
	Minimum	Maximum	Frequency of			Arithmetic				OHM of Potential	
OHM	SQL	SQL	Detection	Minimum	Maximum	Mean	Median	Median	Maximum	Concern? [3]	Reason [4]
Alkalinity - Field			6 / 6	4	192	56	36.25	NA		Yes	
Bicarbonate Alkalinity as CaCO	0 :	20	4 / 7	33	190	46.7143	-1	NA		Yes	
Carbonate, Total as C			3 / 3	4	14	9.3333	10	NA		Yes	
Chloride			11 / 11	24	160	79.8182	77	71	110	Yes	
Nitrate & Nitrite as N			4 / 4	1.2	2.1	1.575	1.5	NA		Yes	
Nitrate as N			7 / 7	0.26	6.35	2.1614	0.58	NA		Yes	
Nitrogen, Ammonia	0.05 :	0.05	6 / 7	0.08	165	42.6436	7	NA		Yes	
Silica as SiO2			7 / 7	0.5	8	3.2143	2.1	NA		Yes	
Sulfate as SO4			11 / 11	25	1000	221.1818	130	NA		Yes	
Sulfide	1 :	1	1 / 7	2	2	0.7143	1	NA		No	FC
Total Iron, Field			7 / 7	0.29	16.4	3.0586	0.83	NA		Yes	
Aluminum, Dissolved	0.1 :	0.1	7 / 12	0.13	2.3	0.3308	0.185	0.1	0.37	Yes	
Arsenic, Dissolved	0.005 :	0.008	2 / 12	0.008	0.01	0.0042	0.008	NA		Yes	
Barium, Dissolved			12 / 12	0.009	0.0455	0.028	0.027	0.018	0.034	Yes	
Calcium, Dissolved			12 / 12	7.9	290	69.6333	31	18	28	No	C
Chromium, Dissolved	0.015 :	0.015	1 / 12	0.017	0.017	0.0079	0.015	NA		No	FC
Iron, Dissolved	0.025 :	0.25	9 / 12	0.081	4.8	0.9088	0.26	0.235	1.8	Yes	
Magnesium, Dissolved			12 / 12	0.81	6.95	3.205	2.7	2.7	3.4	No	C
Manganese, Dissolved			11 / 11	0.013	0.775	0.3306	0.27	0.042	0.1	Yes	
Potassium, Dissolved	0.5 :	3	10 / 12	1.7	4.7	2.3542	2	2.4	3.3	No	BC
Sodium, Dissolved			12 / 12	15	145	66.0833	58	44	58	No	C
Trivalent Chromium, Dissolved	0.015 :	0.015	1 / 7	0.017	0.017	0.0082	0.015	NA		No	FC
Zinc, Dissolved	0.025 :	0.025	4 / 5	0.034	0.044	0.0343	0.037	0.025	0.048	No	B

Notes:

1 Samples included in Site Data set are presented in "Data Used in Risk Assessment" Attachment.
Duplicate samples were averaged with their original samples prior to calculation of statistics.
The arithmetic mean represents the arithmetic average of all sample results, with one-half the reporting limit used as the value for non-detects.
The median represents the median value of all sample results, including non-detects, with the reporting limit used as the value for non-detects.

2 The background data set is presented in Section 4.1 of the Phase II Report and in Attachment "Background Characterization".
For OHM with site-specific background data, the maximum detected concentration in the background data set and the median concentration are reported.
The median concentration represents the median of all samples in the background data set, with the reporting limit used as the value for non-detects.

3 OHM of Potential Concern are OHM that are inconsistent with background conditions and not detected at a low frequency and low concentration.

4 Reason for exclusion as OHM of Potential Concern:
B = Background; the concentration of OHM in the site data is consistent with the concentration of OHM in the background data, as determined by the following criteria (MADEP, 1995):

TABLE 4

IDENTIFICATION OF ECOLOGICAL OHM OF POTENTIAL CONCERN - SURFACE WATER (FILTERED, RECENT DATA)

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

	Site Data/Concentration [1]							Background Concentration [2]		OHM of Potential	
	Minimum	Maximum	Frequency of			Arithmetic					
OHM	SQL	SQL	Detection	Minimum	Maximum	Mean	Median	Median	Maximum	Concern? [3]	Reason [4]

(1) For OHM with site-specific background data: (a) the maximum detected site concentration is less than or equal to the maximum site-specific background concentration, and the median site concentration is not more than 50% greater than the median site-specific background concentration; (b) the median site concentration is less than or equal to the median site-specific background concentration and the maximum detected site concentration is not more than 50% greater than the maximum site-specific background concentration; (c) both the maximum and median site concentrations are equal to or less than the maximum and median site-specific background concentrations, respectively.

C = Calcium, magnesium, potassium, and sodium were not considered to be OHM, as they are essential nutrients.

FC = Low Frequency and Concentration; the OHM was not detected in more than two samples and the maximum detected concentration was not more than two times the minimum SQL.

OHM = Oil or Hazardous Material

SQL = Sample Quantitation Limit

NB = Not judged to be a background analyte (see background discussion).

ND = Not detected in background data set.

NA = Not Available/Not Applicable

MADEP (1995): Guidance for Disposal Site Risk Characterization - In Support of the Massachusetts Contingency Plan (WSC/ORS-95-141, July).

TABLE 5
IDENTIFICATION OF ECOLOGICAL OHM OF POTENTIAL CONCERN - SEDIMENT

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

OHM	Site Data/Concentration [1]							Background Concentration [2]		OHM of Potential Concern? [3]	Reason [4]
	Minimum SQL	Maximum SQL	Frequency of Detection	Minimum	Maximum	Arithmetic Mean	Median	Median	Maximum		
VOCs (mg/Kg)											
1,1,1-Trichloroethane	0.005 :	1	5 / 36	0.006	47	1.3251	0.008	< 0.014	0.019	Yes	
1,1,2,2-Tetrachloroethane	0.002 :	1	2 / 34	0.002	0.003	0.0197	0.008	ND		No	FC
1,1-Dichloroethane	0.005 :	1	9 / 35	0.003	0.034	0.02	0.007	ND		Yes	
1,1-Dichloroethene	0.005 :	1	2 / 34	0.0025	0.003	0.0198	0.008	ND		No	FC
1,2-Dichloroethane	0.005 :	1	2 / 34	0.004	0.004	0.0198	0.008	ND		No	FC
1,2-Dichloroethene(total)	0.005 :	1	2 / 35	0.007	0.008	0.0196	0.008	ND		No	FC
2,4,4-Trimethyl-1-pentene	0.01 :	0.02	29 / 36	0.002	28	2.0959	0.12	ND		Yes	
2,4,4-Trimethyl-2-Pentene	0.01 :	0.02	27 / 36	0.002	9.4	0.6369	0.039	ND		Yes	
2-Butanone (MEK)	0.015 :	3	6 / 33	0.012	0.074	0.0659	0.02	< 0.042	0.13	No	B
2-Hexanone	0.015 :	3	2 / 34	0.02	0.036	0.0601	0.02	ND		Yes	
Acetone	0.015 :	3	14 / 36	0.007	1.7	0.1344	0.048	0.042	0.19	Yes	
Benzene	0.005 :	1	3 / 35	0.009	0.015	0.0201	0.009	ND		Yes	
Bromodichloromethane	0.005 :	1	2 / 34	0.004	0.0065	0.0199	0.008	ND		No	FC
Bromoform	0.005 :	1	5 / 34	0.003	0.102	0.0249	0.008	ND		Yes	
Carbon Disulfide	0.01 :	10	3 / 35	0.003	0.005	0.181	0.02	ND		Yes	
Carbon Tetrachloride	0.005 :	1	2 / 34	0.005	0.011	0.0199	0.008	ND		Yes	
Chlorobenzene	0.005 :	1	3 / 35	0.002	0.007	0.0194	0.008	ND		Yes	
Chloroform	0.005 :	1	5 / 34	0.003	0.009	0.0198	0.008	ND		Yes	
Dibromochloromethane	0.005 :	1	3 / 34	0.004	0.026	0.0209	0.008	ND		Yes	
Ethylbenzene	0.005 :	0.046	6 / 34	0.003	0.71	0.0294	0.008	ND		Yes	
Methylene Chloride	0.01 :	2	9 / 35	0.004	0.024	0.0386	0.02	NB		Yes	
Styrene	0.005 :	1	2 / 34	0.004	0.007	0.0199	0.008	ND		No	FC
Tetrachloroethene (PCE)	0.005 :	1	4 / 34	0.003	0.032	0.0201	0.008	0.012	0.025	No	B
Toluene	0.005 :	1	12 / 35	0.002	1.1	0.0511	0.008	ND		Yes	
Trichloroethene (TCE)	0.005 :	1	6 / 35	0.002	0.01	0.0195	0.008	NB		Yes	
Vinyl Chloride	0.01 :	2	1 / 35	0.002	0.002	0.0387	0.02	ND		No	FC
Xylenes, Total	0.005 :	1	7 / 34	0.002	0.25	0.0272	0.008	< 0.012	0.009	Yes	
bis(Chloromethyl)ether	0.5 :	0.5	1 / 2	0.57	0.57	0.41	0.535	ND		Yes	
SVOCs (mg/Kg)											
1,2,4-Trichlorobenzene	0.4 :	1200	7 / 42	0.076	1.4	43.8577	0.5	ND		Yes	
1,2-Dichlorobenzene	0.4 :	1200	1 / 42	1.6	1.6	43.9161	0.5	ND		Yes	
2-Methylnaphthalene	0.4 :	1200	1 / 42	1.4	1.4	43.9101	0.55	ND		Yes	
4-Bromophenyl-phenylether	0.4 :	1200	11 / 42	0.15	3.4	44.1042	0.55	ND		Yes	
4-Chlorophenyl-phenylether	0.4 :	1200	6 / 42	0.058	2.3	43.9806	0.5	ND		Yes	
4-Methylphenol(p-Cresol)	0.4 :	1200	2 / 42	0.089	0.72	43.9508	0.5	ND		No	FC

TABLE 5
IDENTIFICATION OF ECOLOGICAL OHM OF POTENTIAL CONCERN - SEDIMENT

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

	Site Data/Concentration [1]							Background Concentration [2]		OHM of	
	Minimum	Maximum	Frequency of			Arithmetic				Potential	
OHM	SQL	SQL	Detection	Minimum	Maximum	Mean	Median	Median	Maximum	Concern? [3]	Reason [4]
Acenaphthylene	0.4 :	1200	1 / 42	0.021	0.021	43.9913	0.55	ND		No	FC
Anthracene	0.4 :	1200	1 / 42	0.028	0.028	43.9927	0.5	ND		No	FC
Benzo(a)Anthracene	0.4 :	1200	7 / 42	0.095	2.1	43.98	0.5	< 0.0044	0.0056	Yes	
Benzo(a)Pyrene	0.4 :	1200	7 / 42	0.094	0.6	43.9965	0.5	0.67	0.42	No	B
Benzo(b)Fluoranthene	0.4 :	1200	11 / 42	0.052	1.2	43.9824	0.5	0.57	0.75	Yes	
Benzo(g,h,i)Perylene	0.4 :	1200	5 / 42	0.083	0.45	43.9895	0.5	ND		Yes	
Benzo(k)Fluoranthene	0.4 :	1200	3 / 42	0.077	0.41	43.9947	0.5	ND		Yes	
Benzoic Acid	2 :	5800	5 / 41	0.11	2	217.6952	2	ND		Yes	
Butylbenzylphthalate	0.4 :	1200	13 / 41	0.13	160	50.597	0.6	ND		Yes	
Chrysene	0.4 :	1200	8 / 42	0.1	1.3	44.0043	0.5	< 0.0044	0.0053	Yes	
Di-n-butylphthalate	0.4 :	1200	17 / 43	0.016	2100	113.8133	0.5	ND		Yes	
Di-n-octylphthalate	0.4 :	1200	14 / 43	0.091	24	43.6032	0.59	ND		Yes	
Dibenzo(a,h)Anthracene	0.4 :	1200	1 / 42	0.12	0.12	43.9939	0.5	ND		No	FC
Dibenzofuran	0.4 :	1200	2 / 42	1.6	5.9	43.9958	0.55	ND		Yes	
Diethylphthalate	0.4 :	1200	2 / 42	0.12	0.79	43.9532	0.5	ND		No	FC
Dimethylphthalate	0.4 :	1200	3 / 42	0.12	0.53	43.9632	0.5	ND		Yes	
Fluoranthene	0.4 :	1200	18 / 42	0.065	4.1	43.9982	0.5	< 0.67	0.86	Yes	
Fluorene	0.4 :	1200	2 / 42	0.092	4	43.9683	0.55	ND		Yes	
Indeno (1,2,3-cd)Pyrene	0.4 :	1200	11 / 42	0.091	13	44.3041	0.5	ND		Yes	
N-Nitrosodiphenylamine (1)	0.4 :	550	24 / 43	0.18	6200	291.59	0.87	ND		Yes	
Naphthalene	0.4 :	1200	1 / 42	2.2	2.2	43.9292	0.55	ND		Yes	
Phenanthrene	0.4 :	1200	19 / 42	0.054	34	45.0082	0.5	ND		Yes	
Phenol	0.4 :	1100	8 / 43	0.075	56	30.352	0.5	ND		Yes	
Pyrene	0.4 :	1200	21 / 43	0.07	9.1	43.0574	0.5	ND		Yes	
bis(2-Ethylhexyl)phthalate	0.4 :	37	37 / 42	0.082	150000	7847.967	5.25	ND		Yes	
Pesticides/PCBs (mg/Kg)											
4,4'-DDD	0.004 :	0.6	1 / 43	0.19	0.19	0.0523	0.05	0.0076	0.26	Yes	
4,4'-DDT	0.004 :	0.6	3 / 43	0.018	1.2	0.0724	0.05	0.0085	0.031	Yes	
Aldrin	0.002 :	0.3	4 / 42	0.046	0.45	0.0363	0.02	ND		Yes	
Alpha-BHC	0.002 :	0.3	1 / 42	0.0052	0.0052	0.0258	0.02	ND		Yes	
Alpha-Chlordane	0.0022 :	3	1 / 42	0.025	0.025	0.1965	0.0545	< 0.0044	0.056	Yes	
Beta-BHC	0.002 :	0.3	5 / 41	0.0031	0.46	0.0381	0.02	ND		Yes	
Delta-BHC	0.002 :	0.3	5 / 42	0.0054	0.12	0.0288	0.02	ND		Yes	
Dieldrin	0.004 :	0.6	2 / 43	0.0067	0.0072	0.0503	0.05	< 0.0092	0.027	No	FC
Endosulfan I	0.002 :	0.3	6 / 42	0.0032	0.41	0.0352	0.02	ND		Yes	
Endosulfan Sulfate	0.004 :	0.6	6 / 43	0.047	0.24	0.0618	0.05	ND		Yes	

TABLE 5
IDENTIFICATION OF ECOLOGICAL OHM OF POTENTIAL CONCERN - SEDIMENT

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

OHM	Site Data/Concentration [1] Minimum SQL	Maximum SQL	Frequency of Detection	Minimum	Maximum	Arithmetic Mean	Median	Background Concentration [2] Median	Maximum	OHM of Potential Concern? [3]	Reason [4]
Endrin	0.004 :	0.6	1 / 43	0.035	0.035	0.0478	0.05	ND		Yes	
Endrin Aldehyde	0.004 :	0.6	10 / 43	0.012	2.5	0.1167	0.05	ND		Yes	
Endrin Ketone	0.004 :	0.6	1 / 43	0.065	0.065	0.0511	0.05	ND		Yes	
Gamma-Chlordane	0.0022 :	3	1 / 42	0.0036	0.0036	0.1975	0.0595	< 0.0044	0.0053	No	FC
Heptachlor	0.002 :	0.3	3 / 42	0.0006	0.54	0.0344	0.02	ND		Yes	
Heptachlor Epoxide	0.002 :	0.3	4 / 42	0.0046	0.16	0.0292	0.02	ND		Yes	
Methoxychlor	0.02 :	3	1 / 42	0.29	0.29	0.2618	0.2	ND		Yes	
Metals (mg/Kg)											
Aluminum			43 / 43	7.3	150000	11139.9209	5100	6300	12000	Yes	
Antimony	0.96 :	31	22 / 42	0.05	250	30.5719	20	ND		Yes	
Arsenic	0.5 :	23	41 / 43	0.0053	26.4	4.8631	3.8	8.5	44	No	B
Barium			43 / 43	0.0097	74	16.0447	11	32.5	45	Yes	
Beryllium	0.0015 :	3.5	7 / 41	0.22	10.4	0.9709	1.5	ND		Yes	
Cadmium	0.001 :	2.4	4 / 41	0.4	2.7	0.6006	1	ND		Yes	
Calcium			43 / 43	1	7570	974.9372	700	2100	4100	No	C
Chromium			43 / 43	2.1	13800	1563.6907	530	13	19.5	Yes	
Cobalt	1.5 :	2.4	33 / 43	0.0044	38.4	4.5188	3	6.7	6.7	Yes	
Copper	2.5 :	2.5	38 / 41	0.02	120	16.6715	8	21	33	Yes	
Hexavalent Chromium			2 / 2	0.087	0.14	0.1135	0.14	0.53	1.2	No	B
Iron			43 / 43	6.8	83000	9779.4488	5150	6400	14000	No	C
Lead	10 :	12	22 / 41	0.012	170	17.9032	10	26.5	89	Yes	
Magnesium			43 / 43	0.56	2300	777.7028	700	1200	3200	No	B,C
Manganese			43 / 43	0.069	98	42.371	39	128	680	No	B
Mercury	0.0001 :	0.26	18 / 43	0.0001	1.2	0.1958	0.13	0.27	0.54	Yes	
Nickel	4 :	6.3	30 / 43	0.01	110	8.9664	6.2	< 9.6	15.5	Yes	
Potassium			43 / 43	0.34	1200	350.3661	310	490	805	No	B,C
Selenium	0.0005 :	5.7	1 / 42	0.78	0.78	0.5171	0.5	ND		Yes	
Silver	0.0015 :	3.5	2 / 41	2.7	5.8	0.9477	1.5	ND		Yes	
Sodium			43 / 43	0.18	1600	242.5209	150	114	290	No	C
Thallium	0.0008 :	5	1 / 43	3	3	0.5767	0.63	< 3.4	3.6	No	B
Vanadium	2.5 :	2.5	41 / 43	0.009	50.3	12.1493	9.2	16	26	Yes	
Zinc	2.5 :	2.5	42 / 43	0.026	372	37.8875	17	61.5	130	Yes	

TABLE 5
IDENTIFICATION OF ECOLOGICAL OHM OF POTENTIAL CONCERN - SEDIMENT

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

OHM	Site Data/Concentration [1] Minimum SQL	Maximum SQL	Frequency of Detection	Minimum	Maximum	Arithmetic Mean	Median	Background Concentration [2] Median	Maximum	OHM of Potential Concern? [3]	Reason [4]
Inorganics (mg/Kg)											
Chloride	40 :	40	27 / 35	0.064	1400	147.3627	64	NB		Yes	
Nitrate as N			6 / 6	0.0014	3.7	2.0422	2.7	NB		Yes	
Nitrite as N	0.001 :	1	1 / 5	2.2	2.2	0.7401	1	ND		Yes	
Nitrogen, Ammonia	8 :	8	37 / 40	0.16	1000	145.3715	91	ND		Yes	
Sulfate as SO4	40 :	40	34 / 35	80	6000	739.7429	370	ND		Yes	

Notes:

1 Samples included in Site Data set are presented in "Data Used in Risk Assessment" Attachment.
Duplicate samples were averaged with their original samples prior to calculation of statistics.
The arithmetic mean represents the arithmetic average of all sample results, with one-half the reporting limit used as the value for non-detects.
The median represents the median value of all sample results, including non-detects, with the reporting limit used as the value for non-detects.

2 The background data set is presented in Section 4.1 of the Phase II Report and in Attachment "Background Characterization".
For OHM with site-specific background data, the maximum detected concentration in the background data set and the median concentration are reported.
The median concentration represents the median of all samples in the background data set, with the reporting limit used as the value for non-detects.

3 OHM of Potential Concern are OHM that are inconsistent with background conditions and not detected at a low frequency and low concentration.

4 Reason for exclusion as OHM of Potential Concern:
B = Background; the concentration of OHM in the site data is consistent with the concentration of OHM in the background data, as determined by the following criteria (MADEP, 1995):
(1) For OHM with site-specific background data: (a) the maximum detected site concentration is less than or equal to the maximum site-specific background concentration, and the median site concentration is not more than 50% greater than the median site-specific background concentration; (b) the median site concentration is less than or equal to the median site-specific background concentration and the maximum detected site concentration is not more than 50% greater than the maximum site-specific background concentration; (c) both the maximum and median site concentrations are equal to or less than the maximum and median site-specific background concentrations, respectively.
C = Calcium, magnesium, potasium, and sodium, were not considered to be OHM, as they are essential nutrients.
FC = Low Frequency and Concentration; the OHM was not detected in more than two samples and the maximum detected concentration was not more than two times the minimum SQL.

OHM = Oil or Hazardous Material
SQL = Sample Quantitation Limit
NB = Not judged to be a background analyte (see background discussion).
ND = Not detected in background data set.
NA = Not Available/Not Applicable
MADEP (1995): Guidance for Disposal Site Risk Characterization - In Support of the Massachusetts Contingency Plan (WSC/ORS-95-141, July).

TABLE 6
ECOLOGICAL INDICATOR RECEPTORS AND ENDPOINTS

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

Media	Receptor	Assessment Endpoint	Measurement Endpoints
Sediment/ Surface Water	Green heron	Reduction in heron subpopulation size from food chain exposure Reduction in heron subpopulation size from decreased prey abundance	• Estimated by comparing published avian ingestion toxicity data to predicted dietary exposures based on measured prey (i.e., small mammal, crayfish and frog) tissue concentrations • Based on frog population modeling and measured laboratory toxicity tests
	Green frog	Reduction in resident amphibian population size	• *Statistically significant* (relative to reference location) laboratory toxicity of embryo African clawed frogs following 96-hr sediment elutriate exposures • Population model - 25% decrease in abundance • Field observations of presence/absence of amphibians • Comparison of published amphibian toxicity data to surface water and sediment analytical data
Surface Soil	Woodcock	Reduction in woodcock subpopulation size from food chain exposure Reduction in woodcock subpopulation size from decreased prey abundance	• Estimated by comparing published avian ingestion toxicity data to predicted dietary exposures based on measured prey (i.e., earthworms) tissue concentrations • Based on earthworm (*Eisenia foetida*) population modeling and measured laboratory toxicity tests
	Red fox	Reduction in red fox subpopulation size	• Estimated by comparing published mammalian ingestion toxicity data to predicted dietary exposures based on measured prey (i.e., small mammals) tissue concentrations

TABLE 7
SUMMARY SURFACE SOIL EXPOSURE POINT CONCENTRATIONS - [TERRESTRIAL HABITAT]

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

OHM of Potential Concern [1]	EPCs for Exposure Points [2]					Area-Weighted EPCs for Exposure Points [3]					EPC [5]
	Area A01	Area A02	Area A03	Area A08	Area A09	Area A01	Area A02	Area A03	Area A08	Area A09	
Fraction of Site Area [4]:						0.21	0.08	0.07	0.31	0.33	1.00
VOCs (mg/kg)											
1,1,1-Trichloroethane	0.032	0	0	0.0067	0.017	0.0066	0	0	0.0021	0.0057	0.014
1,1-Dichloroethene	0.0055	0	0	0	0	0.0012	0	0	0	0	0.0012
2,4,4-Trimethyl-1-pentene	0	0	0	0.0043	0	0	0	0	0.0013	0	0.0013
Acetone	0.016	0	0.052	0.0208	0.015	0.0034	0	0	0.0064	0.0050	0.019
Methylene Chloride	0.0064	0	0.029	0.0054	0.008	0.0013	0	0.0020	0.0017	0.0026	0.0077
Tetrachloroethene (PCE)	0.001	0	0.037	0	0	0.0002	0	0.0026	0	0	0.0028
Toluene	0.0041	0	0.0093	0.0033	0.004	0.0009	0	0.0007	0.0010	0.0013	0.0038
SVOCs (mg/kg)											
2-Methylnaphthalene	0	0.067	0	27	0	0	0.0054	0	8.4	0	8.4
Acenaphthene	0	0	0	8.5	0	0	0	0	2.6	0	2.6
Acenaphthylene	0	0	0	20	0.008	0	0	0	6.3	0.0026	6.3
Anthracene	0.035	0	0.002	14	0.005	0.0074	0	0.0001	4.4	0.0017	4.4
Benzo(a)Anthracene	0.099	0.075	0.099	7.02	0.012	0.0208	0.006	0.0069	2.2	0.0040	2.2
Benzo(a)Pyrene	0.059	0.057	0.072	5.1	0.011	0.012	0.0046	0.0050	1.6	0.0036	1.6
Benzo(b)Fluoranthene	0.18	0.13	0.16	2.5	0.013	0.038	0.010	0.011	0.76	0.0043	0.82
Benzo(g,h,i)Perylene	0	0	0	1.8	0	0	0	0	0.55	0	0.55
Benzo(k)Fluoranthene	0.065	0.042	0.039	3.5	0.012	0.014	0.0034	0.0027	1.1	0.0040	1.1
Benzoic Acid	0	0.1	0.039	1.8	0.36	0	0.008	0.0027	0.56	0.12	0.69
Butylbenzylphthalate	0	0	1.09	0.8	0	0	0	0.076	0.25	0	0.32
Chrysene	0.17	0.15	0.15	7.5	0.016	0.036	0.012	0.011	2.3	0.0053	2.4
Di-n-butylphthalate	0.26	0.017	3.5	1.4	0.033	0.055	0.0014	0.25	0.43	0.011	0.75
Di-n-octylphthalate	0	0	1.8	0.17	0	0	0	0.13	0.053	0	0.18
Dibenzofuran	0	0	0	2.2	0	0	0	0	0.696	0	0.70
Diethylphthalate	0.085	0.033	0.01	0.053	0.013	0.018	0.0026	0.0007	0.016	0.0043	0.042
Fluoranthene	0.25	0.099	0.2	20	0.026	0.053	0.0079	0.014	6.1	0.0086	6.2
Fluorene	0	0	0	21	0	0	0	0	6.5	0	6.5
Indeno (1,2,3-cd)Pyrene	0.064	0.051	0.092	1.5	0	0.013	0.0041	0.0064	0.46	0	0.49
N-Nitrosodiphenylamine (1)	1.04	0	11	1	0	0.22	0	0.76	0.31	0	1.3
Naphthalene	0	0.049	0	27	0	0	0.0039	0	8.3	0	8.3
Phenanthrene	0.16	0.17	0.15	50	0.019	0.034	0.014	0.011	16	0.0063	16

TABLE 7
SUMMARY SURFACE SOIL EXPOSURE POINT CONCENTRATIONS - [TERRESTRIAL HABITAT]

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

OHM of Potential Concern [1]	EPCs for Exposure Points [2]					Area-Weighted EPCs for Exposure Points [3]					EPC [5]
	Area A01	Area A02	Area A03	Area A08	Area A09	Area A01	Area A02	Area A03	Area A08	Area A09	
					Fraction of Site Area [4]:	0.21	0.08	0.07	0.31	0.33	1.00
Phenol	0	0	0	2.4	0	0	0	0	0.74	0	0.74
Pyrene	0.16	0.0755	0.18	16	0.02	0.034	0.0060	0.013	5.0	0.0066	5.07
bis(2-EthylHexyl)phthalate	50	0.3	1800	10	0.29	11	0.024	128	3.2	0.095	142
Pesticides/PCBs (mg/kg)											
4,4'-DDD	0	0	0	0.0043	0.0005	0	0	0	0.0013	0	0.0015
4,4'-DDE	0.0037	0.0026	0.002	0.0037	0.0026	0.0008	0.0002	0.0001	0.0011	0.0009	0.0031
4,4'-DDT	*0.30*	*0.0023*	*0.015*	*0.0082*	*0.0073*	*0.063*	*0.0002*	*0.0011*	*0.0025*	*0.0024*	*0.0696*
Aldrin	0.0001	0	0	0.001	0.0019	0.00002	0	0	0.0003	0.0006	0.0010
Alpha-BHC	0.0058	0	0.0773	0.0011	0	0.0012	0	0.0054	0.0003	0	0.0070
Alpha-Chlordane	0	0	0.0002	0.009	0.0003	0	0	0.00001	0.0028	0.00010	0.0029
Dieldrin	0.0006	0.0008	0	0.004	0.001	0.0001	0.00006	0	0.0012	0.0003	0.0018
Endosulfan I	0	0	0	0.0064	0.0021	0	0	0	0.0020	0.0007	0.0027
Endosulfan II	0.0756	0	0.0388	0	0	0.016	0	0.0027	0	0	0.019
Gamma-BHC (Lindane)	0	0.0001	0	0.013	0.0043	0	0.000008	0	0.0041	0.0014	0.0055
Gamma-Chlordane	0	0	0.0003	0.0003	0.0052	0	0	0.00002	0.00009	0.0017	0.0018
Heptachlor Epoxide	0	0.0001	0	0.0001	0.0004	0	0.000008	0	0.00003	0.0001	0.0002
PCB-1016	0.415	0	0	0	0	0.087	0	0	0	0	0.087
Metals (mg/kg)											
Aluminum	15000	4000	6500	3700	4700	3100	317	456	1138	1544	6600
Antimony	24	0	29	1.3	0	5.1	0	2.03	0.403	0	7.5
Arsenic	11	3.9	7.6	6.5	5.8	2.3	0.31	0.53	2.02	1.9	7.05
Barium	20	25	25	11	13	4.3	2.0	1.7	3.4	4.3	16
Beryllium	0.99	0	0	0	0	0.21	0	0	0	0	0.208
Cadmium	1.2	0	0	0	0	0.25	0	0	0	0	0.25
Chromium	1500	5.9	1700	250	17	320	0.47	117	79	5.7	522
Cobalt	10.4	0.46	2.03	1.4	1.01	2.2	0.037	0.14	0.44	0.33	3.1
Copper	15	9.4	14	4.3	8.2	3.2	0.75	1.0	1.3	2.7	9.04
Cyanide	4.6	0	0	0	0	0.96	0	0	0	0	0.96
Lead	31.95	56	32	15	64	6.7	4.5	2.3	4.7	21	39
Manganese	130	21	39	34	24	27	1.7	2.7	10	8.0	50
Mercury	0.66	0.11	1	0.15	0.081	0.14	0.0088	0.070	0.046	0.027	0.29

TABLE 7
SUMMARY SURFACE SOIL EXPOSURE POINT CONCENTRATIONS - [TERRESTRIAL HABITAT]

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

OHM of Potential Concern [1]	EPCs for Exposure Points [2]					Area-Weighted EPCs for Exposure Points [3]					EPC [5]
	Area A01	Area A02	Area A03	Area A08	Area A09	Area A01	Area A02	Area A03	Area A08	Area A09	
Fraction of Site Area [4]:						0.21	0.08	0.07	0.31	0.33	1.00
Nickel	16	5.3	6.07	3.3	3.7	3.3	0.42	0.42	1.02	1.22	6.4
Selenium	1.04	0	0.53	0.86	0	0.22	0	0.037	0.27	0	0.52
Thallium	0.74	0	0	0.83	0.8	0.16	0	0	0.26	0.26	0.68
Vanadium	17	16	18	10	17	3.6	1.3	1.2	3.2	5.5	15
Zinc	44	23	38	16	25	9.2	1.8	2.6	5.0	8.1	27
Inorganics (mg/kg)											
Chloride	286	68	0	110	56	60	5.4	0	34	18	120
Nitrogen, Ammonia	222	25	350	160	98	47	2	25	51	32	160
Sulfate as SO4	990	4.2	60	7300	240	208	0.34	4.2	2200	80	2500

Notes:
1 Selection of OHM of Potential Concern for this medium is presented in "Identification of OHM of Potential Concern - Surface Soil" table.
2 EPCs for each exposure point in this medium are presented in "Surface Soil Exposure Point Concentrations - Area A01, A02, A03, A08, and A09" table.
3 EPCs calculated by multiplying the EPC the exposure point by the fractional site area of that exposure point.
4 Fractional site area represents the area of the exposure point divided by the area of the entire site.
5 The final area-weighted EPC is the sum of the individual area-weighted EPCs for each exposure point.
EPC = Exposure Point Concentration
OHM = Oil or Hazardous Material
MADEP (1995): Guidance for Disposal Site Risk Characterization - In Support of the Massachusetts Contingency Plan (WSC/ORS-95-141, July).

TABLE 8
SURFACE WATER EXPOSURE POINT CONCENTRATIONS
Off-Property West Ditch-Unfiltered, Historical

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

OHM of Potential Concern [1]	Site Data/Concentration [2] Minimum SQL	Maximum SQL	Frequency of Detection	Minimum	Maximum	Arithmetic Mean	EPC [3]
VOCs (mg/L)							
2,4,4-Trimethyl-1-pentene	0.01 :	0.01	3 / 5	0.006	0.2	0.0487	0.0487
2,4,4-Trimethyl-2-Pentene	0.01 :	0.01	3 / 5	0.002	0.081	0.0209	0.0209
Acetone	0.015 :	0.015	1 / 5	0.093	0.093	0.0161	0.0161
Bromoform	0.005 :	0.005	3 / 5	0.001	0.003	0.0023	0.0023
SVOCs (mg/L)							
Di-n-octylphthalate	0.01 :	0.01	1 / 5	0.001	0.001	0.0042	0.001
N-Nitrosodiphenylamine (1)	0.01 :	0.01	3 / 5	0.003	0.031	0.0095	0.0095
Phenol	0.01 :	0.01	4 / 5	0.002	0.003	0.0031	0.003
bis(2-EthylHexyl)phthalate	0.01 :	0.12	1 / 5	0.006	0.006	0.0177	0.006
Pesticides/PCBs (mg/L)							
Heptachlor Epoxide	0.0001 :	0.0001	1 / 5	0.0002	0.0002	0.0001	0.0001
Metals (mg/L)							
Aluminum	0.1 :	0.1	4 / 5	0.32	34	10.764	10.764
Barium			5 / 5	0.018	0.04	0.0274	0.0274
Chromium	0.015 :	0.015	4 / 5	0.032	9.9	2.6579	2.6579
Cobalt	0.015 :	0.015	3 / 5	0.016	0.11	0.0366	0.0366
Copper	0.025 :	0.025	1 / 5	0.12	0.12	0.034	0.034
Hexavalent Chromium			1 / 1	0.2	0.2	0.2	0.2
Iron			5 / 5	0.048	28	7.8156	7.8156
Lead	0.005 :	0.005	1 / 5	0.015	0.015	0.005	0.005
Manganese			5 / 5	0.16	4.4	1.696	1.696
Nickel	0.04 :	0.04	2 / 5	0.049	0.11	0.0438	0.0438
Zinc	0.025 :	0.025	3 / 5	0.0905	0.19	0.0831	0.0831
Inorganics (mg/L)							
Chloride			5 / 5	32	200	125.8	125.8
Nitrate as N			2 / 2	0.2	1.2	0.7	0.7

TABLE 8
SURFACE WATER EXPOSURE POINT CONCENTRATIONS
Off-Property West Ditch-Unfiltered, Historical

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

	Site Data/Concentration [2]						
OHM of Potential Concern [1]	Minimum SQL	Maximum SQL	Frequency of Detection	Minimum	Maximum	Arithmetic Mean	EPC [3]
Nitrogen, Ammonia			5 / 5	3.9	110	62.88	62.88
Sulfate as SO4			5 / 5	78	830	426.6	426.6
Specific Conductance - Field			5 / 5	300	4200	1680	1680

Notes:

1 Selection of OHM of Potential Concern for this medium is presented in "Identification of OHM of Potential Concern - Surface Water (Unfiltered, Historical)" table.

2 Samples included in Site Data set are presented in "Data Used in Risk Assessment" Appendix.
Duplicate samples were averaged with their original samples prior to calculation of summary statistics.
The arithmetic mean represents the arithmetic average of all sample results, with one-half the reporting limit used as the value for non-detects.
The median represents the median value of all sample results, including non-detects, with the reporting limit used as the value for non-detects.

3 The EPC is the arithmetic mean concentration unless the arithmetic mean concentration exceeds the maximum detected concentration (MADEP, 1995). For these OHM, the maximum detected concentration is used as the EPC.

EPC = Exposure Point Concentration
OHM = Oil or Hazardous Material
SQL = Sample Quantitation Limit
MADEP (1995): Guidance for Disposal Site Risk Characterization - In Support of the Massachusetts Contingency Plan (WSC/ORS-95-141, July).

TABLE 9
SURFACE WATER EXPOSURE POINT CONCENTRATIONS
Off-Property West Ditch-Unfiltered, Recent

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

OHM of Potential Concern [1]	Minimum SQL	Maximum SQL	Frequency of Detection	Site Data/Concentration [2] Minimum	Maximum	Arithmetic Mean	EPC [3]
Metals (mg/L)							
Aluminum	0.1 :	0.1	2 / 3	0.11	0.31	0.1567	0.1567
Barium	0 :	0	3 / 3	0.01	0.02	0.015	0.015
Iron	0.37 :	0.37	2 / 3	1.5	5.6	2.4283	2.4283
Manganese	0 :	0	3 / 3	0.014	0.49	0.2007	0.2007
Inorganics (mg/L)							
Chloride	0 :	0	3 / 3	35	82	63	63
Dissolved Oxygen, Field	0 :	0	2 / 3	7.6	10.9	6.1667	6.1667
Nitrate as N	0.05 :	0.05	2 / 3	0.55	0.7	0.425	0.425
Nitrogen, Ammonia	0.05 :	0.05	2 / 3	0.1	6.8	2.3083	2.3083
Sulfate as SO4	0 :	0	3 / 3	25	55	36.3333	36.3333
Sulfide	1 :	1	1 / 3	2	2	1	1

Notes:

1 Selection of OHM of Potential Concern for this medium is presented in "Identification of OHM of Potential Concern - Surface Water (Unfiltered, Recent Data)" table.

2 Samples included in Site Data set are presented in "Data Used in Risk Assessment" Appendix.
Duplicate samples were averaged with their original samples prior to calculation of summary statistics.
The arithmetic mean represents the arithmetic average of all sample results, with one-half the reporting limit used as the value for non-detects.
The median represents the median value of all sample results, including non-detects, with the reporting limit used as the value for non-detects.

3 The EPC is the arithmetic mean concentration unless the arithmetic mean concentration exceeds the maximum detected concentration (MADEP, 1995). For these OHM, the maximum detected concentration is used as the EPC.

EPC = Exposure Point Concentration
OHM = Oil or Hazardous Material
SQL = Sample Quantitation Limit

TABLE 9
SURFACE WATER EXPOSURE POINT CONCENTRATIONS
Off-Property West Ditch-Unfiltered, Recent

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

	Site Data/Concentration [2]						
OHM of Potential Concern [1]	Minimum SQL	Maximum SQL	Frequency of Detection	Minimum	Maximum	Arithmetic Mean	EPC [3]

MADEP (1995): Guidance for Disposal Site Risk Characterization - In Support of the Massachusetts Contingency Plan (WSC/ORS-95-141, July).

TABLE 10
SURFACE WATER EXPOSURE POINT CONCENTRATIONS
On-Property West Ditch-Unfiltered, Historical

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

OHM of Potential Concern[1]	Minimum SQL	Maximum SQL	Frequency of Detection	Minimum	Maximum	Arithmetic Mean	EPC [3]
	Site Data/Concentration [2]						
Metals (mg/L)							
Aluminum			2 / 2	0.17	0.21	0.19	0.19
Arsenic			2 / 2	0.005	0.012	0.0085	0.0085
Barium			2 / 2	0.007	0.009	0.008	0.008
Iron			2 / 2	0.2	0.38	0.29	0.29
Manganese			2 / 2	0.013	0.017	0.015	0.015
Zinc	0.025 :	0.025	1 / 2	0.026	0.026	0.0193	0.0193
Inorganics (mg/L)							
Chloride			2 / 2	180	260	220	220
Nitrate as N			1 / 1	6.4	6.4	6.4	6.4
Nitrite as N			1 / 1	0.054	0.054	0.054	0.054
Nitrogen, Ammonia	0.1 :	0.1	1 / 2	0.26	0.26	0.155	0.155
Sulfate as SO4			2 / 2	76	78	77	77

Notes:

1 Selection of OHM of Potential Concern for this medium is presented in "Identification of OHM of Potential Concern - Surface Water Unfiltered, Historical)" table.

2 Samples included in Site Data set are presented in "Data Used in Risk Assessment" Appendix.
Duplicate samples were averaged with their original samples prior to calculation of summary statistics.
The arithmetic mean represents the arithmetic average of all sample results, with one-half the reporting limit used as the value for non-detects.
The median represents the median value of all sample results, including non-detects, with the reporting limit used as the value for non-detects.

3 The EPC is the arithmetic mean concentration unless the arithmetic mean concentration exceeds the maximum detected concentration (MADEP, 1995). For these OHM, the maximum detected concentration is used as the EPC.

EPC = Exposure Point Concentration

OHM = Oil or Hazardous Material

SQL = Sample Quantitation Limit

MADEP (1995): Guidance for Disposal Site Risk Characterization - In Support of the Massachusetts Contingency Plan (WSC/ORS-95-141, July).

TABLE 11
SURFACE WATER EXPOSURE POINT CONCENTRATIONS
South Ditch-Unfiltered, Historical

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

OHM of Potential Concern[1]	Minimum SQL	Maximum SQL	Frequency of Detection	Minimum	Maximum	Arithmetic Mean	EPC[3]
	Site Data/Concentration[2]						
VOCs (mg/L)							
2,4,4-Trimethyl-1-pentene	0.01 :	0.01	5 / 7	0.0035	0.013	0.0069	0.0069
2,4,4-Trimethyl-2-Pentene	0.01 :	0.01	4 / 7	0.002	0.005	0.0039	0.0039
SVOCs (mg/L)							
Di-n-octylphthalate	0.01 :	0.01	2 / 7	0.001	0.0085	0.0049	0.0049
N-Nitrosodiphenylamine (1)	0.01 :	0.01	5 / 7	0.002	0.0025	0.0029	0.0025
Phenol	0.01 :	0.01	1 / 7	0.001	0.001	0.0044	0.001
bis(2-EthylHexyl)phthalate	0.01 :	0.17	5 / 7	0.002	0.02	0.0178	0.0178
Metals (mg/L)							
Aluminum			7 / 7	1.1	12	5.0357	5.0357
Barium			7 / 7	0.016	0.04	0.0209	0.0209
Chromium			7 / 7	0.057	1.7	0.5477	0.5477
Cobalt	0.015 :	0.015	1 / 7	0.025	0.025	0.01	0.01
Hexavalent Chromium			2 / 2	0.0305	0.074	0.0523	0.0523
Iron			7 / 7	0.35	3.2	2.0571	2.0571
Manganese			7 / 7	0.48	1.25	0.9043	0.9043
Zinc			7 / 7	0.04	0.079	0.0616	0.0616
Inorganics (mg/L)							
Chloride			7 / 7	30	190	150	150
Nitrate as N			2 / 2	5.85	6.6	6.225	6.225
Nitrite as N			2 / 2	0.085	0.331	0.208	0.208
Nitrogen, Ammonia			7 / 7	22	59	44.5714	44.5714
Sulfate as SO4			7 / 7	290	530	378.5714	378.571

Notes:

1 Selection of OHM of Potential Concern for this medium is presented in "Identification of OHM of Potential Concern - Surface Water Unfiltered, Historical Data)" table.

2 Samples included in Site Data set are presented in "Data Used in Risk Assessment" Appendix.
Duplicate samples were averaged with their original samples prior to calculation of summary statistics.
The arithmetic mean represents the arithmetic average of all sample results, with one-half the reporting limit used as the value for non-detects.
The median represents the median value of all sample results, including non-detects, with the reporting limit used as the

TABLE 11
SURFACE WATER EXPOSURE POINT CONCENTRATIONS
South Ditch-Unfiltered, Historical

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

	Site Data/Concentration [2]						
OHM of Potential Concern [1]	Minimum SQL	Maximum SQL	Frequency of Detection	Minimum	Maximum	Arithmetic Mean	EPC [3]

value for non-detects.

3 The EPC is the arithmetic mean concentration unless the arithmetic mean concentration exceeds the maximum detected concentration (MADEP, 1995). For these OHM, the maximum detected concentration is used as the EPC.

EPC = Exposure Point Concentration

OHM = Oil or Hazardous Material

SQL = Sample Quantitation Limit

MADEP (1995): Guidance for Disposal Site Risk Characterization - In Support of the Massachusetts Contingency Plan (WSC/ORS-95-141, July).

TABLE 12
SURFACE WATER EXPOSURE POINT CONCENTRATIONS
South Ditch-Unfiltered, Recent

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

OHM of Potential Concern [1]	Site Data/Concentration [2] Minimum SQL	Maximum SQL	Frequency of Detection	Minimum	Maximum	Arithmetic Mean	EPC [3]
Metals (mg/L)							
Aluminum	0 :	0	3 / 3	0.13	1.6	0.8467	0.8467
Barium	0 :	0	3 / 3	0.019	0.038	0.0253	0.0253
Chromium	0.015 :	0.015	2 / 3	0.0195	0.023	0.0167	0.0167
Trivalent Chromium	0.015 :	0.015	2 / 3	0.0195	0.023	0.0167	0.0167
Iron	0.53 :	0.53	2 / 3	0.54	3.65	1.485	1.485
Manganese	0 :	0	3 / 3	0.26	0.775	0.4983	0.4983
Inorganics (mg/L)							0
Chloride	0 :	0	3 / 3	78	160	119.3333	119.333
Nitrate as N	0 :	0	3 / 3	2.7	7.2	4.7	4.7
Nitrogen, Ammonia	0 :	0	3 / 3	28	91	60.3333	60.3333
Sulfate as SO4	0 :	0	3 / 3	280	1100	636.6667	636.667
Sulfide	1 :	1	2 / 3	2	5	1.75	1.75

Notes:

1 Selection of OHM of Potential Concern for this medium is presented in "Identification of OHM of Potential Concern - Surface Water (Unfiltered, Recent Data)" table.

2 Samples included in Site Data set are presented in "Data Used in Risk Assessment" Appendix.
Duplicate samples were averaged with their original samples prior to calculation of summary statistics.
The arithmetic mean represents the arithmetic average of all sample results, with one-half the reporting limit used as the value for non-detects.
The median represents the median value of all sample results, including non-detects, with the reporting limit used as the value for non-detects.

3 The EPC is the arithmetic mean concentration unless the arithmetic mean concentration exceeds the maximum detected concentration (MADEP, 1995). For these OHM, the maximum detected concentration is used as the EPC.

EPC = Exposure Point Concentration

OHM = Oil or Hazardous Material

TABLE 12
SURFACE WATER EXPOSURE POINT CONCENTRATIONS
South Ditch-Unfiltered, Recent

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

OHM of Potential Concern [1]	Site Data/Concentration [2]						EPC [3]
	Minimum SQL	Maximum SQL	Frequency of Detection	Minimum	Maximum	Arithmetic Mean	

SQL = Sample Quantitation Limit

MADEP (1995): Guidance for Disposal Site Risk Characterization - In Support of the Massachusetts Contingency Plan (WSC/ORS-95-141, July).

TABLE 13
SURFACE WATER EXPOSURE POINT CONCENTRATIONS
Ephemeral Drainage-Unfiltered, Historical

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

OHM of Potential Concern[1]	Site Data/Concentration[2]						EPC[3]
	Minimum SQL	Maximum SQL	Frequency of Detection	Minimum	Maximum	Arithmetic Mean	
SVOCs (mg/L)							
Di-n-octylphthalate	0.01 :	0.01	1 / 3	0.006	0.006	0.0053	0.0053
bis(2-EthylHexyl)phthalate	0.01 :	0.01	2 / 3	0.002	0.007	0.0047	0.0047
Metals (mg/L)							
Aluminum			3 / 3	1.2	21	9.3667	9.3667
Arsenic	0.005 :	0.005	1 / 3	0.25	0.25	0.085	0.085
Barium			3 / 3	0.026	0.055	0.0377	0.0377
Chromium	0.015 :	0.015	1 / 3	0.13	0.13	0.0483	0.0483
Cobalt	0.015 :	0.015	1 / 3	0.02	0.02	0.0117	0.0117
Iron			3 / 3	0.45	72	25.5833	25.5833
Lead	0.005 :	0.005	1 / 3	0.18	0.18	0.0617	0.0617
Manganese			3 / 3	0.6	0.76	0.7	0.7
Mercury	0.0002 :	0.0002	1 / 3	0.0009	0.0009	0.0004	0.0004
Vanadium	0.025 :	0.025	1 / 3	0.19	0.19	0.0717	0.0717
Zinc			3 / 3	0.053	0.096	0.0743	0.0743
Inorganics (mg/L)							
Chloride			3 / 3	13	21	17.6667	17.6667
Nitrogen, Ammonia	0.1 :	0.1	2 / 3	0.59	2.4	1.0133	1.0133
Sulfate as SO4			3 / 3	120	290	216.6667	216.6667

Notes:

1 Selection of OHM of Potential Concern for this medium is presented in "Identification of OHM of Potential Concern - Surface Water Unfiltered, Historical Data)" table.

2 Samples included in Site Data set are presented in "Data Used in Risk Assessment" Appendix.
Duplicate samples were averaged with their original samples prior to calculation of summary statistics.
The arithmetic mean represents the arithmetic average of all sample results, with one-half the reporting limit used as the value for non-detects.
The median represents the median value of all sample results, including non-detects, with the reporting limit used as the

TABLE 13
SURFACE WATER EXPOSURE POINT CONCENTRATIONS
Ephemeral Drainage-Unfiltered, Historical

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

	Site Data/Concentration [2]						
OHM of Potential Concern[1]	Minimum SQL	Maximum SQL	Frequency of Detection	Minimum	Maximum	Arithmetic Mean	EPC [3]

value for non-detects.

3 The EPC is the arithmetic mean concentration unless the arithmetic mean concentration exceeds the maximum detected concentration (MADEP, 1995). For these OHM, the maximum detected concentration is used as the EPC.

EPC = Exposure Point Concentration

OHM = Oil or Hazardous Material

SQL = Sample Quantitation Limit

MADEP (1995): Guidance for Disposal Site Risk Characterization - In Support of the Massachusetts Contingency Plan (WSC/ORS-95-141, July).

TABLE 14
SURFACE WATER EXPOSURE POINT CONCENTRATIONS
Ephemeral Drainage-Unfiltered, Recent

STAGE II ENVIRONMENTAL RISK CHARACTERIAZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

OHM of Potential Concern [1]	Site Data/Concentration [2]						EPC [3]
	Minimum SQL	Maximum SQL	Frequency of Detection	Minimum	Maximum	Arithmetic Mean	
Metals (mg/L)							
Aluminum	0 :	0	1 / 1	2.4	2.4	2.4	2.4
Barium	0 :	0	1 / 1	0.032	0.032	0.032	0.032
Iron	0 :	0	1 / 1	0.75	0.75	0.75	0.75
Manganese	0 :	0	1 / 1	0.56	0.56	0.56	0.56
Inorganics (mg/L)							
Chloride	0 :	0	1 / 1	24	24	24	24
Nitrate as N	0 :	0	1 / 1	0.25	0.25	0.25	0.25
Nitrogen, Ammonia	0 :	0	1 / 1	2	2	2	2
Sulfate as SO4	0 :	0	1 / 1	130	130	130	130

Notes:
1 Selection of OHM of Potential Concern for this medium is presented in "Identification of OHM of Potential Concern - Surface Water (Unfiltered, Recent Data)" table.
2 Samples included in Site Data set are presented in "Data Used in Risk Assessment" Appendix.
Duplicate samples were averaged with their original samples prior to calculation of summary statistics.
The arithmetic mean represents the arithmetic average of all sample results, with one-half the reporting limit used as the value for non-detects.
The median represents the median value of all sample results, including non-detects, with the reporting limit used as the value for non-detects.
3 The EPC is the arithmetic mean concentration unless the arithmetic mean concentration exceeds the maximum detected concentration (MADEP, 1995). For these OHM, the maximum detected concentration is used as the EPC.
EPC = Exposure Point Concentration
OHM = Oil or Hazardous Material
SQL = Sample Quantitation Limit
MADEP (1995): Guidance for Disposal Site Risk Characterization - In Support of the Massachusetts Contingency Plan (WSC/ORS-95-141, July).

TABLE 15
SURFACE WATER EXPOSURE POINT CONCENTRATIONS
Central Pond-Unfiltered, Recent

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

OHM of Potential Concern[1]	Site Data/Concentration[2]						EPC[3]
	Minimum SQL	Maximum SQL	Frequency of Detection	Minimum	Maximum	Arithmetic Mean	
Metals (mg/L)							
Aluminum			1 / 1	0.84	0.84	0.84	0.84
Barium			1 / 1	0.02	0.02	0.02	0.02
Chromium			1 / 1	0.02	0.02	0.02	0.02
Iron			1 / 1	0.082	0.082	0.082	0.082
Manganese			1 / 1	0.23	0.23	0.23	0.23
Inorganics (mg/L)							
Chloride			1 / 1	42	42	42	42
Nitrate & Nitrite as N			1 / 1	6.8	6.8	6.8	6.8
Sulfate as SO4			1 / 1	630	630	630	630

Notes:

1 Selection of OHM of Potential Concern for this medium is presented in "Identification of OHM of Potential Concern - Surface Water (Unfiltered, Recent Data)" table.

2 Samples included in Site Data set are presented in "Data Used in Risk Assessment" Appendix.
Duplicate samples were averaged with their original samples prior to calculation of summary statistics.
The arithmetic mean represents the arithmetic average of all sample results, with one-half the reporting limit used as the value for non-detects.
The median represents the median value of all sample results, including non-detects, with the reporting limit used as the value for non-detects.

3 The EPC is the arithmetic mean concentration unless the arithmetic mean concentration exceeds the maximum detected concentration (MADEP, 1995). For these OHM, the maximum detected concentration is used as the EPC.

EPC = Exposure Point Concentration

OHM = Oil or Hazardous Material

SQL = Sample Quantitation Limit

MADEP (1995): Guidance for Disposal Site Risk Characterization - In Support of the Massachusetts Contingency Plan (WSC/ORS-95-141, July).

TABLE 16
SEDIMENT EXPOSURE POINT CONCENTRATIONS - [Off-Property West Ditch]

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

OHM of Potential Concern[1]	Site Data/Concentration[2] Minimum SQL	Maximum SQL	Frequency of Detection	Minimum	Maximum	Arithmetic Mean	EPC[3]
VOCs (mg/Kg)							
1,1,1-Trichloroethane	0.007 :	0.02	4 / 11	0.006	0.0185	0.0067	0.0067
1,1-Dichloroethane	0.007 :	0.02	2 / 10	0.003	0.004	0.0045	0.004
2,4,4-Trimethyl-1-pentene	0.01 :	0.01	10 / 11	0.006	6.5	0.7579	0.7579
2,4,4-Trimethyl-2-Pentene	0.01 :	0.01	10 / 11	0.002	1.8	0.2139	0.2139
Acetone	0.015 :	0.092	4 / 11	0.009	0.093	0.0285	0.0285
Bromoform	0.007 :	0.01	5 / 10	0.003	0.102	0.0219	0.0219
Carbon Tetrachloride	0.007 :	0.01	2 / 10	0.005	0.011	0.0048	0.0048
Chloroform	0.007 :	0.01	5 / 10	0.003	0.009	0.0046	0.0046
Dibromochloromethane	0.007 :	0.02	3 / 10	0.004	0.026	0.0082	0.0082
Methylene Chloride	0.01 :	0.05	2 / 11	0.004	0.01	0.0088	0.0088
Toluene	0.007 :	0.02	4 / 10	0.002	0.012	0.0058	0.0058
Trichloroethene (TCE)	0.007 :	0.02	3 / 10	0.002	0.003	0.0041	0.003
Xylenes, Total	0.007 :	0.02	1 / 10	0.006	0.006	0.0047	0.0047
SVOCs (mg/Kg)							
1,2,4-Trichlorobenzene	0.4 :	0.9	2 / 12	0.076	0.21	0.2455	0.21
4-Bromophenyl-phenylether	0.4 :	0.9	6 / 12	0.15	0.65	0.35	0.35
4-Chlorophenyl-phenylether	0.4 :	1	2 / 12	0.058	0.1	0.2741	0.1
Benzo(a)Anthracene	0.4 :	0.9	5 / 12	0.11	0.49	0.2833	0.2833
Benzo(b)Fluoranthene	0.4 :	0.9	6 / 12	0.052	1.2	0.4501	0.4501
Benzo(g,h,i)Perylene	0.4 :	0.9	4 / 12	0.11	0.45	0.2842	0.2842
Benzo(k)Fluoranthene	0.4 :	0.9	3 / 12	0.077	0.41	0.2803	0.2803
Benzoic Acid	2 :	7	1 / 12	0.17	0.17	1.4238	0.17
Chrysene	0.4 :	0.9	5 / 12	0.2	0.73	0.3604	0.3604
Di-n-butylphthalate	0.4 :	1	1 / 12	0.086	0.086	0.2788	0.086
Fluoranthene	0.4 :	0.5	7 / 12	0.083	1.7	0.6314	0.6314
Indeno (1,2,3-cd)Pyrene	0.4 :	0.9	7 / 12	0.14	0.56	0.2904	0.2904
N-Nitrosodiphenylamine (1)	0.4 :	0.9	4 / 12	0.18	0.91	0.3579	0.3579

TABLE 16
SEDIMENT EXPOSURE POINT CONCENTRATIONS - [Off-Property West Ditch]

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

OHM of Potential Concern[1]	Site Data/Concentration [2]						EPC [3]
	Minimum SQL	Maximum SQL	Frequency of Detection	Minimum	Maximum	Arithmetic Mean	
Phenanthrene	0.4 :	0.9	7 / 12	0.13	0.57	0.2808	0.2808
Pyrene	0.4 :	0.5	8 / 12	0.167	1.1	0.4289	0.4289
bis(2-EthylHexyl)phthalate	0.4 :	0.9	10 / 12	0.325	4.5	1.4792	1.4792
Pesticides/PCBs (mg/Kg)							
4,4'-DDD	0.004 :	0.07	1 / 12	0.19	0.19	0.0235	0.0235
Alpha-BHC	0.002 :	0.08	1 / 11	0.0052	0.0052	0.0083	0.0052
Beta-BHC	0.002 :	0.04	4 / 11	0.0031	0.21	0.024	0.024
Delta-BHC	0.002 :	0.04	5 / 11	0.0054	0.12	0.0198	0.0198
Endosulfan I	0.002 :	0.04	3 / 11	0.0032	0.15	0.0184	0.0184
Endosulfan Sulfate	0.004 :	0.07	2 / 12	0.074	0.24	0.0318	0.0318
Endrin Aldehyde	0.004 :	0.2	3 / 12	0.012	0.012	0.0172	0.012
Heptachlor Epoxide	0.002 :	0.04	3 / 11	0.0046	0.16	0.021	0.021
Metals (mg/Kg)							
Aluminum			12 / 12	3100	150000	21854.1667	21854.2
Antimony	0.96 :	20	6 / 11	34	250	64.4073	64.4073
Barium			12 / 12	3.6	29	12.6583	12.6583
Beryllium	1.5 :	3.5	2 / 11	0.3	1.9	0.9227	0.9227
Cadmium	0.24 :	2.4	1 / 11	2.1	2.1	0.6836	0.6836
Chromium			12 / 12	103	8900	2210.25	2210.25
Cobalt	1.5 :	1.5	11 / 12	1.5	6.6	3.425	3.425
Copper			11 / 11	3.4	120	27.0568	27.0568
Lead	10 :	10	5 / 11	3	100	17.0909	17.0909
Mercury	0.1 :	0.2	2 / 12	0.21	0.96	0.1498	0.1498
Nickel	4 :	4	9 / 12	4.2	18	7.0313	7.0313
Vanadium			12 / 12	4.1	31	12.7	12.7
Zinc			12 / 12	8.1	60	18.3708	18.3708
Inorganics (mg/Kg)							
Chloride	40 :	40	10 / 11	46	1400	316.3182	316.318

TABLE 16
SEDIMENT EXPOSURE POINT CONCENTRATIONS - [Off-Property West Ditch]

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

OHM of Potential Concern[1]	Site Data/Concentration[2]						EPC[3]
	Minimum SQL	Maximum SQL	Frequency of Detection	Minimum	Maximum	Arithmetic Mean	
Nitrate as N			2 / 2	2.6	3.15	2.875	2.875
Nitrogen, Ammonia	8 :	8	9 / 11	11.7	1000	189.7909	189.791
Sulfate as SO4			11 / 11	100	6000	1127.7273	1127.73

Notes:

1 Selection of OHM of Potential Concern for this medium is presented in "Identification of OHM of Potential Concern - Sediment" table.

2 Samples included in Site Data set are presented in "Data Used in Risk Assessment" Appendix.
Duplicate samples were averaged with their original samples prior to calculation of summary statistics.
The arithmetic mean represents the arithmetic average of all sample results, with one-half the reporting limit used as the value for non-detects.

3 The EPC is the arithmetic mean concentration unless the arithmetic mean concentration exceeds the maximum detected concentration (MADEP, 1995). For these OHM, the maximum detected concentration is used as the EPC.

EPC = Exposure Point Concentration

OHM = Oil or Hazardous Material

SQL = Sample Quantitation Limit

MADEP (1995): Guidance for Disposal Site Risk Characterization - In Support of the Massachusetts Contingency Plan (WSC/ORS-95-141, July).

TABLE 17
SEDIMENT EXPOSURE POINT CONCENTRATIONS - [On-Property West Ditch]

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

OHM of Potential Concern[1]	Site Data/Concentration[2] Minimum SQL	Maximum SQL	Frequency of Detection	Minimum	Maximum	Arithmetic Mean	EPC[3]
VOCs (mg/Kg)							
2,4,4-Trimethyl-1-pentene			4 / 4	0.049	28	10.3323	10.3323
2,4,4-Trimethyl-2-Pentene			4 / 4	0.018	9.4	3.6533	3.6533
Acetone	0.053 :	3	2 / 4	0.055	0.15	0.4329	0.15
Benzene	0.007 :	1	1 / 4	0.015	0.015	0.1306	0.015
Chlorobenzene	0.007 :	1	1 / 4	0.007	0.007	0.1286	0.007
Ethylbenzene	0.007 :	0.007	3 / 4	0.003	0.71	0.2066	0.2066
Toluene	0.007 :	1	2 / 4	0.002	1.1	0.4014	0.4014
SVOCs (mg/Kg)							
1,2,4-Trichlorobenzene	0.5 :	1200	1 / 6	1.4	1.4	146.6	1.4
1,2-Dichlorobenzene	0.5 :	1200	1 / 6	1.6	1.6	146.6333	1.6
2-Methylnaphthalene	0.5 :	1200	1 / 6	1.4	1.4	146.6	1.4
Benzo(a)Anthracene	0.5 :	1200	1 / 6	2.1	2.1	147.1333	2.1
Benzo(b)Fluoranthene	0.5 :	1200	2 / 6	0.11	0.87	146.8717	0.87
Benzoic Acid	2 :	5800	2 / 6	0.22	2	713.0367	2
Butylbenzylphthalate	550 :	1200	4 / 6	0.5	160	181.1333	160
Di-n-butylphthalate	550 :	1200	4 / 6	0.14	2100	729.4233	729.423
Di-n-octylphthalate	550 :	1200	4 / 6	0.59	2.1	146.7533	2.1
Dibenzofuran	0.5 :	1200	2 / 6	1.6	5.9	147.2	5.9
Dimethylphthalate	5 :	1200	2 / 6	0.12	0.18	147.1333	0.18
Fluoranthene	0.5 :	1200	1 / 6	4.1	4.1	147.05	4.1
Fluorene	0.5 :	1200	1 / 6	4	4	147.0333	4
N-Nitrosodiphenylamine (1)	550 :	550	5 / 6	7.2	6200	1891.3667	1891.37
Naphthalene	0.5 :	1200	1 / 6	2.2	2.2	146.7333	2.2
Phenanthrene	550 :	1200	4 / 6	0.075	34	153.8692	34
Phenol	5 :	550	3 / 6	1	56	56.9667	56
Pyrene	0.5 :	1200	2 / 6	0.11	9.1	147.8267	9.1
bis(2-EthylHexyl)phthalate			6 / 6	1300	150000	37716.6667	37716.7

TABLE 17
SEDIMENT EXPOSURE POINT CONCENTRATIONS - [On-Property West Ditch]

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

OHM of Potential Concern[1]	Site Data/Concentration[2] Minimum SQL	Maximum SQL	Frequency of Detection	Minimum	Maximum	Arithmetic Mean	EPC[3]
Pesticides/PCBs (mg/Kg)							
4,4'-DDT	0.05 :	0.5	1 / 6	1.2	1.2	0.2692	0.2692
Aldrin	0.02 :	0.2	2 / 6	0.046	0.45	0.1083	0.1083
Beta-BHC	0.02 :	0.2	1 / 6	0.46	0.46	0.1074	0.1074
Endosulfan I	0.02 :	0.2	1 / 6	0.41	0.41	0.0991	0.0991
Endrin Aldehyde	0.05 :	0.12	3 / 6	0.055	2.5	0.5525	0.5525
Heptachlor	0.02 :	0.2	2 / 6	0.0018	0.54	0.1163	0.1163
Metals (mg/Kg)							
Aluminum			6 / 6	2600	6800	4883.3333	4883.33
Antimony	20 :	20	2 / 6	1.1	1.9	7.1667	1.9
Barium			6 / 6	9.9	41.6	24.7	24.7
Beryllium	0.3 :	1.5	1 / 6	0.28	0.28	0.5717	0.28
Cadmium	1 :	1	2 / 6	0.4	1.3	0.6167	0.6167
Chromium			6 / 6	54	580	269.1667	269.167
Cobalt	1.5 :	1.5	4 / 6	1.5	3.6	1.8833	1.8833
Copper			6 / 6	6.2	24	13.0667	13.0667
Lead	10 :	10	4 / 6	12	55	17.25	17.25
Mercury	0.13 :	0.14	4 / 6	0.14	0.79	0.2525	0.2525
Nickel	4 :	4	4 / 6	7.6	13	7.1167	7.1167
Vanadium			6 / 6	8.9	32	17.8667	17.8667
Zinc			6 / 6	25	113	73.6667	73.6667
Inorganics (mg/Kg)							
Chloride			4 / 4	83	130	110.75	110.75
Nitrate as N			1 / 1	3.7	3.7	3.7	3.7
Nitrite as N			1 / 1	2.2	2.2	2.2	2.2
Nitrogen, Ammonia			6 / 6	24	227	106	106
Sulfate as SO4			4 / 4	96	680	324	324

TABLE 17
SEDIMENT EXPOSURE POINT CONCENTRATIONS - [On-Property West Ditch]

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

	Site Data/Concentration [2]						
	Minimum	Maximum	Frequency of			Arithmetic	
OHM of Potential Concern[1]	SQL	SQL	Detection	Minimum	Maximum	Mean	EPC [3]

Notes:

1 Selection of OHM of Potential Concern for this medium is presented in "Identification of OHM of Potential Concern - Sediment" table.

2 Samples included in Site Data set are presented in "Data Used in Risk Assessment" Appendix.
Duplicate samples were averaged with their original samples prior to calculation of summary statistics.
The arithmetic mean represents the arithmetic average of all sample results, with one-half the reporting limit used as the value for non-detects.

3 The EPC is the arithmetic mean concentration unless the arithmetic mean concentration exceeds the maximum detected concentration (MADEP, 1995). For these OHM, the maximum detected concentration is used as the EPC.

EPC = Exposure Point Concentration

OHM = Oil or Hazardous Material

SQL = Sample Quantitation Limit

MADEP (1995): Guidance for Disposal Site Risk Characterization - In Support of the Massachusetts Contingency Plan (WSC/ORS-95-141, July).

TABLE 18
SEDIMENT EXPOSURE POINT CONCENTRATIONS - [South Ditch]

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

	Site Data/Concentration [2]						
OHM of Potential Concern[1]	Minimum SQL	Maximum SQL	Frequency of Detection	Minimum	Maximum	Arithmetic Mean	EPC [3]
VOCs (mg/Kg)							
1,1,1-Trichloroethane	0.007 :	0.04	1 / 14	47	47	3.3621	3.3621
1,1-Dichloroethane	0.007 :	0.04	6 / 14	0.003	0.034	0.0075	0.0075
2,4,4-Trimethyl-1-pentene	0.02 :	0.02	13 / 14	0.002	4.7	0.9813	0.9813
2,4,4-Trimethyl-2-Pentene	0.01 :	0.02	12 / 14	0.012	1.5	0.2936	0.2936
2-Hexanone	0.02 :	0.1	2 / 13	0.02	0.036	0.0174	0.0174
Acetone	0.03 :	0.25	6 / 14	0.03	1.7	0.1904	0.1904
Benzene	0.007 :	0.04	2 / 14	0.009	0.014	0.0063	0.0063
Carbon Disulfide	0.01 :	10	3 / 14	0.003	0.005	0.3658	0.005
Chlorobenzene	0.007 :	0.04	2 / 14	0.002	0.003	0.005	0.003
Ethylbenzene	0.007 :	0.01	3 / 13	0.004	0.023	0.006	0.006
Methylene Chloride	0.01 :	0.08	3 / 13	0.004	0.013	0.0111	0.0111
Toluene	0.007 :	0.01	3 / 14	0.003	0.027	0.0057	0.0057
Trichloroethene (TCE)	0.007 :	0.04	3 / 14	0.005	0.01	0.006	0.006
Xylenes, Total	0.007 :	0.01	4 / 13	0.002	0.25	0.0235	0.0235
bis(Chloromethyl)ether	0.5 :	0.5	1 / 2	0.57	0.57	0.41	0.41
SVOCs (mg/Kg)							
1,2,4-Trichlorobenzene	0.4 :	800	4 / 15	0.083	1.2	26.9779	1.2
4-Bromophenyl-phenylether	0.4 :	800	4 / 15	0.47	3	27.3143	3
4-Chlorophenyl-phenylether	0.4 :	800	3 / 15	0.23	2	27.1023	2
Benzo(b)Fluoranthene	0.4 :	800	1 / 15	0.064	0.064	27.0813	0.064
Benzoic Acid	2 :	3900	2 / 15	0.11	0.59	131.38	0.59
Butylbenzylphthalate	0.4 :	800	9 / 14	0.13	17	30.6754	17
Chrysene	0.4 :	800	2 / 15	0.1	1.3	27.0703	1.3
Di-n-butylphthalate	0.4 :	800	11 / 16	0.016	60	29.1421	29.1421
Di-n-octylphthalate	0.4 :	800	9 / 16	0.091	24	27.3685	24
Dimethylphthalate	0.4 :	800	1 / 15	0.53	0.53	27.029	0.53
Fluoranthene	0.4 :	800	8 / 15	0.065	0.64	26.9067	0.64

TABLE 18
SEDIMENT EXPOSURE POINT CONCENTRATIONS - [South Ditch]

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

OHM of Potential Concern[1]	Site Data/Concentration[2] Minimum SQL	Maximum SQL	Frequency of Detection	Minimum	Maximum	Arithmetic Mean	EPC[3]
Fluorene	0.4 :	800	1 / 15	0.092	0.092	27.0831	0.092
Indeno (1,2,3-cd)Pyrene	0.4 :	800	3 / 15	0.48	13	27.969	13
N-Nitrosodiphenylamine (1)	0.61 :	0.8	14 / 16	0.24	720	70.4416	70.4416
Phenanthrene	0.4 :	800	7 / 15	0.054	4.2	27.2779	4.2
Phenol	0.4 :	800	5 / 16	0.075	0.58	25.3166	0.58
Pyrene	0.4 :	800	8 / 16	0.076	0.93	25.3236	0.93
bis(2-EthylHexyl)phthalate	0.8 :	37	13 / 15	0.26	57000	6402.2507	6402.25
Pesticides/PCBs (mg/Kg)							
4,4'-DDT	0.004 :	0.6	2 / 16	0.018	0.069	0.0581	0.0581
Endosulfan I	0.002 :	0.3	2 / 16	0.0081	0.028	0.0304	0.028
Endosulfan Sulfate	0.004 :	0.6	4 / 16	0.047	0.17	0.0738	0.0738
Endrin Aldehyde	0.004 :	0.6	4 / 16	0.071	0.14	0.0698	0.0698
Heptachlor	0.002 :	0.3	1 / 16	0.0006	0.0006	0.0288	0.0006
Heptachlor Epoxide	0.002 :	0.3	1 / 16	0.006	0.006	0.0291	0.006
Methoxychlor	0.02 :	3	1 / 16	0.29	0.29	0.3003	0.29
Metals (mg/Kg)							
Aluminum			16 / 16	7.3	13000	5041.0375	5041.04
Antimony	20 :	25	11 / 16	0.05	69	24.8711	24.8711
Barium			16 / 16	0.0097	43	12.9014	12.9014
Beryllium	0.0015 :	2	2 / 15	0.38	0.41	0.6794	0.41
Chromium			16 / 16	2.1	2900	1059.9063	1059.91
Cobalt	1.5 :	1.8	13 / 16	0.0044	19	4.9944	4.9944
Copper	2.5 :	2.5	13 / 15	0.02	19	7.5305	7.5305
Lead	10 :	10	8 / 16	0.012	170	17.6582	17.6582
Mercury	0.0001 :	0.17	10 / 16	0.0001	1.2	0.2094	0.2094
Nickel	4 :	4.9	13 / 16	0.01	25	7.3364	7.3364
Silver	0.0015 :	2	1 / 15	2.7	2.7	0.8361	0.8361
Vanadium	2.5 :	2.5	14 / 16	0.009	13	7.3513	7.3513

TABLE 18
SEDIMENT EXPOSURE POINT CONCENTRATIONS - [South Ditch]

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

OHM of Potential Concern[1]	Site Data/Concentration[2]						EPC[3]
	Minimum SQL	Maximum SQL	Frequency of Detection	Minimum	Maximum	Arithmetic Mean	
Zinc	2.5 :	2.5	15 / 16	0.026	150	32.4759	32.4759
Inorganics (mg/Kg)							
Chloride	40 :	40	13 / 14	0.064	240	79.6567	79.6567
Nitrate as N			3 / 3	0.0014	2.8	0.9343	0.9343
Nitrogen, Ammonia			15 / 15	0.16	639	172.4107	172.411
Sulfate as SO4			14 / 14	130	3200	806.4286	806.429

Notes:

1 Selection of OHM of Potential Concern for this medium is presented in "Identification of OHM of Potential Concern - Sediment" table.

2 Samples included in Site Data set are presented in "Data Used in Risk Assessment" Appendix.
Duplicate samples were averaged with their original samples prior to calculation of summary statistics.
The arithmetic mean represents the arithmetic average of all sample results, with one-half the reporting limit used as the value for non-detects.

3 The EPC is the arithmetic mean concentration unless the arithmetic mean concentration exceeds the maximum detected concentration (MADEP, 1995). For these OHM, the maximum detected concentration is used as the EPC.

EPC = Exposure Point Concentration

OHM = Oil or Hazardous Material

SQL = Sample Quantitation Limit

MADEP (1995): Guidance for Disposal Site Risk Characterization - In Support of the Massachusetts Contingency Plan (WSC/ORS-95-141, July).

TABLE 19
SEDIMENT EXPOSURE POINT CONCENTRATIONS - [Ephemeral Drainage]

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

OHM of Potential Concern[1]	Site Data/Concentration[2]						EPC[3]
	Minimum SQL	Maximum SQL	Frequency of Detection	Minimum	Maximum	Arithmetic Mean	
VOCs (mg/Kg)							
2,4,4-Trimethyl-1-pentene	0.01 :	0.02	1 / 6	0.004	0.004	0.0082	0.004
Acetone	0.02 :	0.031	1 / 6	0.007	0.007	0.0121	0.007
Methylene Chloride	0.02 :	0.02	3 / 6	0.008	0.024	0.0117	0.0117
Toluene	0.005 :	0.01	3 / 6	0.002	0.006	0.0035	0.0035
Xylenes, Total	0.005 :	0.01	1 / 6	0.004	0.004	0.0039	0.0039
SVOCs (mg/Kg)							
Benzo(a)Anthracene	0.4 :	0.6	1 / 6	0.095	0.095	0.2325	0.095
Benzo(b)Fluoranthene	0.4 :	0.6	2 / 6	0.069	0.18	0.2082	0.18
Benzo(g,h,i)Perylene	0.4 :	0.6	1 / 6	0.083	0.083	0.2305	0.083
Chrysene	0.4 :	0.6	1 / 6	0.14	0.14	0.24	0.14
Fluoranthene	0.4 :	0.6	2 / 6	0.079	0.21	0.2148	0.21
Indeno (1,2,3-cd)Pyrene	0.4 :	0.6	1 / 6	0.091	0.091	0.2318	0.091
Phenanthrene	0.4 :	0.6	1 / 6	0.13	0.13	0.2383	0.13
Pyrene	0.4 :	0.5	3 / 6	0.07	0.18	0.1703	0.1703
bis(2-EthylHexyl)phthalate	2.7 :	2.7	5 / 6	0.082	5.9	1.7838	1.7838
Metals (mg/Kg)							
Aluminum			6 / 6	2400	10000	5266.6667	5266.67
Barium			6 / 6	5.9	18	10.8	10.8
Chromium			6 / 6	5.4	20	11.7	11.7
Cobalt	1.5 :	2.4	2 / 6	2.6	7.2	2.2333	2.2333
Copper	2.5 :	2.5	5 / 6	3.6	7	4.5417	4.5417
Lead	10 :	12	2 / 5	15	31	12.4	12.4
Nickel	4 :	6.3	1 / 6	6.9	6.9	3.0667	3.0667
Selenium	0.5 :	2.5	1 / 6	0.78	0.78	0.5058	0.5058
Silver	1.5 :	2.4	1 / 6	5.8	5.8	1.6917	1.6917
Vanadium			6 / 6	3.6	10	7.6667	7.6667
Zinc			6 / 6	3.9	19	8.3833	8.3833

TABLE 19
SEDIMENT EXPOSURE POINT CONCENTRATIONS - [Ephemeral Drainage]

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

OHM of Potential Concern[1]	Minimum SQL	Maximum SQL	Frequency of Detection	Minimum	Maximum	Arithmetic Mean	EPC[3]
	Site Data/Concentration[2]						
Inorganics (mg/Kg)							
Nitrogen, Ammonia	8 :	8	5 / 6	18	89	31.8333	31.8333
Sulfate as SO4	40 :	40	5 / 6	80	210	150	150

Notes:

1 Selection of OHM of Potential Concern for this medium is presented in "Identification of OHM of Potential Concern - Sediment" table.

2 Samples included in Site Data set are presented in "Data Used in Risk Assessment" Appendix.
Duplicate samples were averaged with their original samples prior to calculation of summary statistics.
The arithmetic mean represents the arithmetic average of all sample results, with one-half the reporting limit used as the value for non-detects.

3 The EPC is the arithmetic mean concentration unless the arithmetic mean concentration exceeds the maximum detected concentration (MADEP, 1995). For these OHM, the maximum detected concentration is used as the EPC.

EPC = Exposure Point Concentration

OHM = Oil or Hazardous Material

SQL = Sample Quantitation Limit

MADEP (1995): Guidance for Disposal Site Risk Characterization - In Support of the Massachusetts Contingency Plan (WSC/ORS-95-141, July).

TABLE 20
SEDIMENT EXPOSURE POINT CONCENTRATIONS - [Central Pond]

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

OHM of Potential Concern[1]	Site Data/Concentration[2]						EPC[3]
	Minimum SQL	Maximum SQL	Frequency of Detection	Minimum	Maximum	Arithmetic Mean	
VOCs (mg/Kg)							
1,1-Dichloroethane			1 / 1	0.014	0.014	0.014	0.014
2,4,4-Trimethyl-1-pentene			1 / 1	12	12	12	12
2,4,4-Trimethyl-2-Pentene			1 / 1	1.8	1.8	1.8	1.8
Acetone			1 / 1	0.055	0.055	0.055	0.055
Methylene Chloride			1 / 1	0.022	0.022	0.022	0.022
Xylenes, Total			1 / 1	0.033	0.033	0.033	0.033
SVOCs (mg/Kg)							
4-Bromophenyl-phenylether	0.42 :	1100	1 / 3	3.4	3.4	184.5367	3.4
4-Chlorophenyl-phenylether	0.42 :	1100	1 / 3	2.3	2.3	184.17	2.3
Di-n-butylphthalate	0.42 :	5.9	1 / 3	43	43	15.3867	15.3867
Di-n-octylphthalate	0.42 :	1100	1 / 3	1.2	1.2	183.8033	1.2
N-Nitrosodiphenylamine (1)	0.42 :	5.9	1 / 3	54	54	19.0533	19.0533
bis(2-EthylHexyl)phthalate			3 / 3	2.4	6400	2417.4667	2417.47
Pesticides/PCBs (mg/Kg)							
Aldrin	0.0022 :	0.0022	2 / 3	0.052	0.26	0.1044	0.1044
Alpha-Chlordane	0.0022 :	0.23	1 / 3	0.025	0.025	0.047	0.025
Endrin	0.0042 :	0.45	1 / 3	0.035	0.035	0.0874	0.035
Metals (mg/Kg)							
Aluminum			3 / 3	3600	66700	25070	25070
Antimony			3 / 3	1.3	51.8	22.3667	22.3667
Barium			3 / 3	8.5	74	39.5333	39.5333
Beryllium	0.63 :	0.63	2 / 3	0.22	10.4	3.645	3.645
Cadmium	0.21 :	1.3	1 / 3	2.7	2.7	1.1517	1.1517
Chromium			3 / 3	472	13800	7357.3333	7357.33
Cobalt			3 / 3	1.8	38.4	16.2	16.2
Copper			3 / 3	4.6	97.7	55.7667	55.7667
Lead			3 / 3	2.3	59.7	32.6667	32.6667

TABLE 20
SEDIMENT EXPOSURE POINT CONCENTRATIONS - [Central Pond]

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

	Site Data/Concentration [2]						
OHM of Potential Concern[1]	Minimum SQL	Maximum SQL	Frequency of Detection	Minimum	Maximum	Arithmetic Mean	EPC [3]
Mercury	0.086 :	0.086	2 / 3	0.54	0.78	0.4543	0.4543
Nickel			3 / 3	5.2	110	40.9	40.9
Thallium	1.5 :	5	1 / 3	3	3	2.0833	2.0833
Vanadium			3 / 3	9.9	50.3	33.0667	33.0667
Zinc			3 / 3	11.8	372	132.2667	132.267
Inorganics (mg/Kg)							
Nitrogen, Ammonia			2 / 2	29	285	157	157

Notes:

1 Selection of OHM of Potential Concern for this medium is presented in "Identification of OHM of Potential Concern - Sediment" table.

2 Samples included in Site Data set are presented in "Data Used in Risk Assessment" Appendix.
Duplicate samples were averaged with their original samples prior to calculation of summary statistics.
The arithmetic mean represents the arithmetic average of all sample results, with one-half the reporting limit used as the value for non-detects.

3 The EPC is the arithmetic mean concentration unless the arithmetic mean concentration exceeds the maximum detected concentration (MADEP, 1995). For these OHM, the maximum detected concentration is used as the EPC.

EPC = Exposure Point Concentration

OHM = Oil or Hazardous Material

SQL = Sample Quantitation Limit

MADEP (1995): Guidance for Disposal Site Risk Characterization - In Support of the Massachusetts Contingency Plan (WSC/ORS-95-141, July).

TABLE 21
SEDIMENT EXPOSURE POINT CONCENTRATIONS - [Floc]

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

	Site Data/Concentration [2]						
OHM of Potential Concern [1]	Minimum SQL	Maximum SQL	Frequency of Detection	Minimum	Maximum	Arithmetic Mean	EPC [3]
Metals (mg/Kg)							
Aluminum			2 / 2	70000	77000	73500	73500
Barium			2 / 2	32	4600	2316	2316
Beryllium			2 / 2	6.1	6.7	6.4	6.4
Cadmium	1.2 :	1.2	1 / 2	2.8	2.8	1.7	1.7
Chromium			7 / 7	930	35000	12576	12576
Cobalt	3.6 :	3.6	1 / 2	15	15	8.4	8.4
Copper			2 / 2	25	270	147.5	147.5
Nickel			2 / 2	8.8	18	13.4	13.4
Vanadium			2 / 2	11	81	46	46
Zinc			2 / 2	110	3400	1755	1755
Inorganics (mg/Kg)							
Chloride			1 / 1	210	210	210	210
Sulfate as SO4			1 / 1	740	740	740	740

Notes:

1 Selection of OHM of Potential Concern for this medium is presented in "Identification of OHM of Potential Concern - Sediment" table.

2 Samples included in Site Data set are presented in "Data Used in Risk Assessment" Appendix.
Duplicate samples were averaged with their original samples prior to calculation of summary statistics.
The arithmetic mean represents the arithmetic average of all sample results, with one-half the reporting limit used as the value for non-detects.

3 The EPC is the arithmetic mean concentration unless the arithmetic mean concentration exceeds the maximum detected concentration (MADEP, 1995). For these OHM, the maximum detected concentration is used as the EPC.

EPC = Exposure Point Concentration

OHM = Oil or Hazardous Material

SQL = Sample Quantitation Limit

MADEP (1995): Guidance for Disposal Site Risk Characterization - In Support of the Massachusetts Contingency Plan (WSC/ORS-95-141, July).

TABLE 22
TISSUE EXPOSURE POINT CONCENTRATIONS - [Small Mammals]

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

Analyte [1]	Site Data/Concentration [2] Minimum SQL	Maximum SQL	Frequency of Detection	Minimum	Maximum	Arithmetic Mean	EPC [3]
SVOCs (mg/Kg)							
1,2,4-Trichlorobenzene	0.19	0.8	0				
1,2-Dichlorobenzene	0.19	0.8	0				
1,3-Dichlorobenzene	0.19	0.8	0				
1,4-Dichlorobenzene	0.19	0.8	0				
2,2'-oxybis(1-Chloropropane)	0.19	0.8	0				
2,3,6-Trichlorophenol	0.19	0.8	0				
2,4,5-Trichlorophenol	0.19	0.8	0				
2,4,6-Trichlorophenol	0.19	0.8	0				
2,4-Dichlorophenol	0.19	0.8	0				
2,4-Dimethylphenol	0.19	0.8	0				
2,4-Dinitrophenol	0.94	4	0				
2,4-Dinitrotoluene	0.19	0.8	0				
2,6-Dinitrotoluene	0.19	0.8	0				
2-Chloronaphthalene	0.19	0.8	0				
2-Chlorophenol	0.19	0.8	0				
2-Nitrophenol	0.19	0.8	0				
3,3'-Dichlorobenzidine	0.19	0.8	0				
4,6-Dinitro2methylphenol	0.19	0.8	0				
4-Bromophenyl-phenylether	0.19	0.8	0				
4-Chloro-3-Methylphenol	0.19	0.8	0				
4-Chlorophenylphenylether	0.19	0.8	0				
4-Nitrophenol	0.94	4	0				
Acenaphthene	0.19	0.8	0				
Acenaphthylene	0.19	0.8	0				
Anthracene	0.19	0.8	0				
Azobenzene	0.19	0.8	0				
Benzidine	0.19	0.8	0				
Benzo(a)anthracene	0.19	0.8	0				
Benzo(a)pyrene	0.19	0.8	0				
Benzo(b)fluoranthene	0.19	0.8	0				

TABLE 22
TISSUE EXPOSURE POINT CONCENTRATIONS - [Small Mammals]

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

	Site Data/Concentration [2]						
Analyte [1]	Minimum SQL	Maximum SQL	Frequency of Detection	Minimum	Maximum	Arithmetic Mean	EPC [3]
Benzo(g,h,i)perylene	0.19	0.8	0				
Benzo(k)fluoranthene	0.19	0.8	0				
Biphenyl	0.19	0.8	0				
Butylbenzylphthalate	0.19	0.8	0				
Carbazole	0.19	0.8	0				
Chrysene	0.19	0.8	0				
Di-n-butylphthalate	0.19	0.8	0				
Di-n-octylphthalate	0.19	0.8	0				
Dibenz(a,h)anthracene	0.19	0.8	0				
Dibenzofuran	0.19	0.8	0				
Dibenzothiophene	0.19	0.8	0				
Diethylphthalate	0.19	0.8	0				
Dimethylphthalate	0.19	0.8	0				
Fluoranthene	0.19	0.8	0				
Fluorene	0.19	0.8	0				
Hexachlorobenzene	0.19	0.8	0				
Hexachlorobutadiene	0.19	0.8	0				
Hexachlorocyclopentadiene	0.94	4	0				
Hexachloroethane	0.19	0.8	0				
Indeno(1,2,3-cd)pyrene	0.19	0.8	0				
Isophorone	0.19	0.8	0				
N-Nitrosodimethylamine	0.19	0.8	0				
N-Nitrosodinpropylamine	0.19	0.8	0				
N-Nitrosodiphenylamine	0.19	0.8	0				
Naphthalene	0.19	0.8	0				
Nitrobenzene	0.19	0.8	0				
Pentachlorophenol	0.94	4	0				
Phenanthrene	0.19	0.8	0				
Phenol	0.75 :	0.8	1 / 5	0.26	0.26	0.361	0.26
Pyrene	0.19	0.8	0				
bis(2-Chloroethyl)Ether	0.19	0.8	0				

TABLE 22
TISSUE EXPOSURE POINT CONCENTRATIONS - [Small Mammals]

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

	Site Data/Concentration [2]						
Analyte [1]	Minimum SQL	Maximum SQL	Frequency of Detection	Minimum	Maximum	Arithmetic Mean	EPC [3]
bis(2Ethylhexyl)phthalate	0 :	0	5 / 5	1	12	5.1	5.1
Pesticides/PCBs (mg/Kg)							
4,4'-DDD	0.0028	0.0037	0				
4,4'-DDE	0.0029 :	0.0037	2 / 15	0.0048	0.011	0.0024	0.0024
4,4'-DDT	0.0029 :	0.0037	3 / 15	0.0015	0.0052	0.002	0.002
Aldrin	0.0015	0.0019	0				
Dieldrin	0.0029 :	0.0037	2 / 15	0.0023	0.0029	0.0017	0.0017
Endosulfan I	0.0015	0.0019	0				
Endosulfan II	0.0028	0.0037	0				
Endosulfan sulfate	0.0029 :	0.0037	2 / 15	0.0062	0.015	0.0028	0.0028
Endrin	0.0029 :	0.0037	3 / 15	0.0013	0.0038	0.0017	0.0017
Endrin aldehyde	0.0028 :	0.0037	2 / 15	0.0017	0.0019	0.0016	0.0016
Endrin ketone	0.0028	0.0037	0				
Heptachlor	0.0015	0.0019	0				
Heptachlor Epoxide	0.0015 :	0.0019	1 / 15	0.0086	0.0086	0.0013	0.0013
Methoxychlor	0.015	0.019	0				
Toxaphene	0.15	0.19	0				
alpha-BHC	0.0015	0.0019	0				
alpha-Chlordane	0.0015	0.0019	0				
beta-BHC	0.0015	0.0019	0				
delta-BHC	0.0015	0.0019	0				
gamma-BHC (Lindane)	0.0015	0.0019	0				
gamma-Chlordane	0.0015	0.0019	0				
Metals (mg/Kg)							
Aluminium	1.7524 :	1.7524	14 / 15	1.8201	9.751	5.1685	5.1685
Antimony	0.0946 :	0.1478	9 / 15	0.152	0.3795	0.1591	0.1591
Arsenic	0.1388 :	0.2167	3 / 15	0.216	0.2394	0.1249	0.1249
Barium	0 :	0	15 / 15	0.5032	3.4416	1.7307	1.7307
Beryllium	0.0063	0.0099	0				
Cadmium	0.0233 :	0.0296	6 / 15	0.0341	0.1181	0.039	0.039
Calcium	0 :	0	15 / 15	4791.798	14489.27	8115.9939	8115.99

TABLE 22
TISSUE EXPOSURE POINT CONCENTRATIONS - [Small Mammals]

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

	Site Data/Concentration [2]						
Analyte [1]	Minimum SQL	Maximum SQL	Frequency of Detection	Minimum	Maximum	Arithmetic Mean	EPC [3]
Chromium Total	0 :	0	15 / 15	0.146	1.3362	0.4212	0.4212
Cobalt	0.0544 :	0.064	5 / 15	0.0566	0.0984	0.0436	0.0436
Copper	0 :	0	15 / 15	1.8786	5.0856	3.3066	3.3066
Iron	0 :	0	15 / 15	35.1942	118.2008	66.9343	66.9343
Lead	0.092 :	0.1133	9 / 15	0.1005	1.1544	0.1931	0.1931
Magnesium	0 :	0	15 / 15	282.3301	603.8647	412.3291	412.329
Manganese	0 :	0	15 / 15	2.518	13.9803	7.869	7.869
Mercury	0.0034 :	0.01	3 / 15	0.0093	0.0371	0.0081	0.0081
Nickel	0.1046 :	0.1126	13 / 15	0.1519	0.577	0.2849	0.2849
Potassium	0 :	0	15 / 15	1965.534	3611.1111	2955.1823	2955.18
Selenium	0 :	0	15 / 15	0.279	0.8921	0.5959	
Silver	0.0584 :	0.0739	1 / 15	0.0736	0.0736	0.0366	0.0366
Sodium	0 :	0	15 / 15	867.9612	1424.1379	1220.4051	1220.41
Thallium	0.1293 :	0.202	3 / 15	0.1808	0.2142	0.1114	0.1114
Vanadium	0.0777 :	0.0777	14 / 15	0.0926	0.3658	0.1972	0.1972
Zinc	0 :	0	15 / 15	17.8398	34.6351	27.8444	27.8444

Notes:

1 EPCs are calculated for all analytes detected in tissue; however, only the analytes identified as OHMPC in surface soil were included in the food chain model.

2 Samples included in Site Data set are presented in "Data Used in Risk Assessment" Appendix.
Duplicate samples were averaged with their original samples prior to calculation of summary statistics.
The arithmetic mean represents the arithmetic average of all sample results, with one-half the reporting limit used as the value for non-detects.

3 The EPC is the arithmetic mean concentration unless the arithmetic mean concentration exceeds the maximum detected concentration (MADEP, 1995). For these OHM, the maximum detected concentration is used as the EPC.

EPC = Exposure Point Concentration

OHM = Oil or Hazardous Material

SQL = Sample Quantitation Limit

MADEP (1995): Guidance for Disposal Site Risk Characterization - In Support of the Massachusetts Contingency Plan (WSC/ORS-95-141, July).

TABLE 23
TISSUE EXPOSURE POINT CONCENTRATIONS - [Plants]

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

Analyte [1]	Site Data/Concentration [2]						EPC [3]
	Minimum SQL	Maximum SQL	Frequency of Detection	Minimum	Maximum	Arithmetic Mean	
Pesticides/PCBs (mg/Kg)							
4,4'-DDD	0.0033	0.0033	0				
4,4'-DDE	0.0033	0.0033	0				
4,4'-DDT	0.0033	0.0033	0				
Aldrin	0.0017	0.0017	0				
Aroclor-1016	0.033	0.033	0				
Aroclor-1221	0.067	0.067	0				
Aroclor-1232	0.033	0.033	0				
Aroclor-1242	0.033	0.033	0				
Aroclor-1248	0.033	0.033	0				
Aroclor-1254	0.033	0.033	0				
Aroclor-1260	0.033	0.033	0				
Dieldrin	0.0033	0.0033	0				
Endosulfan I	0.0017	0.0017	0				
Endosulfan II	0.0033	0.0033	0				
Endosulfan sulfate	0.0033	0.0033	0				
Endrin	0.0033	0.0033	0				
Endrin aldehyde	0.0033	0.0033	0				
Endrin ketone	0.0033	0.0033	0				
Heptachlor	0.0017 :	0.0017	1 / 4	0.0011	0.0011	0.0009	0.0009
Heptachlor Epoxide	0.0017	0.0017	0				
Toxaphene	0.17	0.17	0				
alpha-BHC	0.0017 :	0.0017	3 / 4	0.0009	0.001	0.0009	0.0009
alpha-Chlordane	0.0017 :	0.0017	2 / 4	0.0009	0.0011	0.0009	0.0009
beta-BHC	0.0017	0.0017	0				
delta-BHC	0.0017 :	0.0017	2 / 4	0.002	0.0029	0.0017	0.0017
gamma-BHC (Lindane)	0.0017 :	0.0017	2 / 4	0.001	0.0012	0.001	0.001
gamma-Chlordane	0.0017	0.0017	0				

TABLE 23
TISSUE EXPOSURE POINT CONCENTRATIONS - [Plants]

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

Analyte [1]	Minimum SQL	Maximum SQL	Frequency of Detection	Minimum	Maximum	Arithmetic Mean	EPC [3]
	Site Data/Concentration [2]						
p,p'-Methoxychlor	0.017	0.017	0				
Metals (mg/Kg)							
Aluminum	0 :	0	4 / 4	34.0375	124.5783	72.0417	72.0417
Antimony	0.1497	0.1735	0				
Arsenic	0.1164	0.1349	0				
Barium	0 :	0	4 / 4	0.8256	3.4388	1.9371	1.9371
Beryllium	0.0125	0.0145	0				
Cadmium	0 :	0	4 / 4	0.0227	0.0298	0.026	0.026
Calcium	0 :	0	4 / 4	617.3494	1488.8372	949.4947	949.4947
Chromium Total	0 :	0	4 / 4	0.2151	8.4434	2.4596	2.4596
Cobalt	0.0958 :	0.107	2 / 4	0.0981	0.2973	0.1242	0.1242
Copper	0 :	0	4 / 4	0.7074	3.1022	1.5994	1.5994
Iron	0 :	0	4 / 4	60.8372	254.3133	137.3654	137.3654
Lead	0 :	0	4 / 4	0.134	0.8063	0.4127	0.4127
Magnesium	0 :	0	4 / 4	115.907	327.0417	234.7386	234.7386
Manganese	0 :	0	4 / 4	5.6558	72.4819	46.9601	46.9601
Mercury	0.0091 :	0.01	1 / 4	0.0092	0.0092	0.0059	0.0059
Nickel	0 :	0	4 / 4	0.2084	0.5716	0.3738	0.3738
Potassium	0 :	0	4 / 4	1687.917	2634.2168	2254.4336	2254.434
Selenium	0.1442 :	0.1442	3 / 4	0.1733	0.2305	0.1729	0.1729
Silver	0.0499	0.0578	0				
Sodium	0 :	0	4 / 4	133.0602	957.0833	480.5381	480.5381
Thallium	0.1674 :	0.1674	3 / 4	0.1655	0.1997	0.1588	0.1588
Vanadium	0.0837 :	0.0837	3 / 4	0.1825	0.5588	0.2425	0.2425
Zinc	0 :	0	4 / 4	4.9628	25.8292	14.5616	14.5616

Notes:

1 EPCs are calculated for all analytes detected in tissue; however, only the analytes identified as OHMPC in surface soil were included in the food chain model.

TABLE 23
TISSUE EXPOSURE POINT CONCENTRATIONS - [Plants]

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

	Site Data/Concentration [2]						
Analyte [1]	Minimum SQL	Maximum SQL	Frequency of Detection	Minimum	Maximum	Arithmetic Mean	EPC [3]

2 Samples included in Site Data set are presented in "Data Used in Risk Assessment" Appendix.
Duplicate samples were averaged with their original samples prior to calculation of summary statistics.
The arithmetic mean represents the arithmetic average of all sample results, with one-half the reporting limit used as the value for non-detects.

3 The EPC is the arithmetic mean concentration unless the arithmetic mean concentration exceeds the maximum detected concentration (MADEP, 1995). For these OHM, the maximum detected concentration is used as the EPC.

EPC = Exposure Point Concentration

OHM = Oil or Hazardous Material

SQL = Sample Quantitation Limit

MADEP (1995): Guidance for Disposal Site Risk Characterization - In Support of the Massachusetts Contingency Plan (WSC/ORS-95-141, July).

TABLE 24
TISSUE EXPOSURE POINT CONCENTRATIONS - [Crayfish]

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

Analyte [1]	Site Data/Concentration [2]						EPC [3]
	Minimum SQL	Maximum SQL	Frequency of Detection	Minimum	Maximum	Arithmetic Mean	
SVOCs (mg/Kg)							
1,2,4-Trichlorobenzene	0.098	0.12	0				
1,2-Dichlorobenzene	0.098	0.12	0				
1,3-Dichlorobenzene	0.098	0.12	0				
1,4-Dichlorobenzene	0.098	0.12	0				
2,2'-oxybis(1-Chloropropane)	0.098	0.12	0				
2,3,6-Trichlorophenol	0.098	0.12	0				
2,4,5-Trichlorophenol	0.098	0.12	0				
2,4,6-Trichlorophenol	0.098	0.12	0				
2,4-Dichlorophenol	0.098	0.12	0				
2,4-Dimethylphenol	0.098	0.12	0				
2,4-Dinitrophenol	0.098	0.12	0				
2,4-Dinitrotoluene	0.098	0.12	0				
2,6-Dinitrotoluene	0.098	0.12	0				
2-Chloronaphthalene	0.098	0.12	0				
2-Chlorophenol	0.098	0.12	0				
2-Nitrophenol	0.098	0.12	0				
3,3'-Dichlorobenzidine	0.098	0.12	0				
4,6-Dinitro2methylphenol	0.098	0.12	0				
4-Bromophenyl-phenylether	0.098	0.12	0				
4-Chloro-3-Methylphenol	0.098	0.12	0				
4-Chlorophenylphenylether	0.098	0.12	0				
4-Nitrophenol	0.49	0.61	0				
Acenaphthene	0.098	0.12	0				
Acenaphthylene	0.098	0.12	0				
Anthracene	0.098	0.12	0				
Azobenzene	0.098	0.12	0				
Benzidine	0.098	0.12	0				

TABLE 24
TISSUE EXPOSURE POINT CONCENTRATIONS - [Crayfish]

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

	Site Data/Concentration [2]						
Analyte [1]	Minimum SQL	Maximum SQL	Frequency of Detection	Minimum	Maximum	Arithmetic Mean	EPC [3]
Benzo(a)anthracene	0.098	0.12	0				
Benzo(a)pyrene	0.098	0.12	0				
Benzo(b)fluoranthene	0.098	0.12	0				
Benzo(g,h,i)perylene	0.098	0.12	0				
Benzo(k)fluoranthene	0.098	0.12	0				
Biphenyl	0.098	0.12	0				
Butylbenzylphthalate	0.098	0.12	0				
Carbazole	0.098	0.12	0				
Chrysene	0.098	0.12	0				
Di-n-butylphthalate	0.098	0.12	0				
Di-n-octylphthalate	0.098	0.12	0				
Dibenz(a,h)anthracene	0.098	0.12	0				
Dibenzofuran	0.098	0.12	0				
Dibenzothiophene	0.098	0.12	0				
Diethylphthalate	0.098	0.12	0				
Dimethylphthalate	0.098	0.12	0				
Fluoranthene	0.098	0.12	0				
Fluorene	0.098	0.12	0				
Hexachlorobenzene	0.098	0.12	0				
Hexachlorobutadiene	0.098	0.12	0				
Hexachlorocyclopentadiene	0.098	0.12	0				
Hexachloroethane	0.098	0.12	0				
Indeno(1,2,3-cd)pyrene	0.098	0.12	0				
Isophorone	0.098	0.12	0				
N-Nitrosodimethylamine	0.098	0.12	0				
N-Nitrosodinpropylamine	0.098	0.12	0				
N-Nitrosodiphenylamine	0.098	0.12	0				
Naphthalene	0.098	0.12	0				

TABLE 24
TISSUE EXPOSURE POINT CONCENTRATIONS - [Crayfish]

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

Analyte [1]	Site Data/Concentration [2] Minimum SQL	Maximum SQL	Frequency of Detection	Minimum	Maximum	Arithmetic Mean	EPC [3]
Nitrobenzene	0.098	0.12	0				
Pentachlorophenol	0.098	0.12	0				
Phenanthrene	0.098	0.12	0				
Phenol	0.098 :	0.12	1 / 4	0.16	0.16	0.0795	0.0795
Pyrene	0.098	0.12	0				
bis(2-Chloroethyl)Ether	0.098	0.12	0				
bis(2Ethylhexyl)phthalate	0.098 :	0.098	3 / 4	0.89	5.9	2.4598	2.4598
Pesticides/PCBs (mg/Kg)							
4,4'-DDD	0.0032	0.0033	0				
4,4'-DDE	0.0032 :	0.0033	1 / 9	0.0083	0.0083	0.0024	0.0024
4,4'-DDT	0.0032	0.0033	0				
Aldrin	0.0017	0.0017	0				
Aroclor-1016	0.032	0.033	0				
Aroclor-1221	0.066	0.067	0				
Aroclor-1232	0.032	0.033	0				
Aroclor-1242	0.032	0.033	0				
Aroclor-1248	0.032	0.033	0				
Aroclor-1254	0.032	0.033	0				
Aroclor-1260	0.032	0.033	0				
Dieldrin	0.0032	0.0033	0				
Endosulfan I	0.0017	0.0017	0				
Endosulfan II	0.0032	0.0033	0				
Endosulfan sulfate	0.0032	0.0033	0				
Endrin	0.0032	0.0033	0				
Endrin aldehyde	0.0032	0.0033	0				
Endrin ketone	0.0032	0.0033	0				
Heptachlor	0.0017	0.0017	0				
Heptachlor Epoxide	0.0017	0.0017	0				

TABLE 24
TISSUE EXPOSURE POINT CONCENTRATIONS - [Crayfish]

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

Analyte [1]	Site Data/Concentration [2]						EPC [3]
	Minimum SQL	Maximum SQL	Frequency of Detection	Minimum	Maximum	Arithmetic Mean	
Toxaphene	0.17	0.17	0				
alpha-BHC	0.0017	0.0017	0				
alpha-Chlordane	0.0017	0.0017	0				
beta-BHC	0.0017	0.0017	0				
delta-BHC	0.0017	0.0017	0				
gamma-BHC (Lindane)	0.0017	0.0017	0				
gamma-Chlordane	0.0017	0.0017	0				
p,p'-Methoxychlor	0.017	0.017	0				
Metals (mg/Kg)							
Aluminium	0 :	0	8 / 8	73.2084	152.9004	96.458	96.458
Antimony	0.1532	0.1727	0				
Arsenic	0.1247 :	0.1247	7 / 8	0.1266	0.394	0.2384	0.2384
Barium	0 :	0	8 / 8	12.8775	26.4967	18.5747	18.5747
Beryllium	0.0128	0.0144	0				
Cadmium	0 :	0	8 / 8	0.0421	0.0626	0.053	0.053
Calcium	0 :	0	8 / 8	30876.595	50370.37	38439.5433	38439.5
Chromium Total	0 :	0	8 / 8	7.5338	30.0823	14.7641	14.7641
Cobalt	0 :	0	8 / 8	0.2412	0.3919	0.314	0.314
Copper	0 :	0	8 / 8	30	36.1151	33.5405	33.5405
Iron	0 :	0	8 / 8	151.8931	340.7792	225.2869	225.287
Lead	0 :	0	8 / 8	0.2377	0.6584	0.3703	0.3703
Magnesium	0 :	0	8 / 8	228.9087	522.5108	307.636	307.636
Manganese	0 :	0	8 / 8	14.1114	66.9717	36.4503	36.4503
Mercury	0 :	0	8 / 8	0.0229	0.0307	0.0264	0.0264
Nickel	0.1218 :	0.1218	7 / 8	0.1403	0.2693	0.1611	0.1611
Potassium	0 :	0	8 / 8	1745.657	2107.9136	1911.3371	1911.34
Selenium	0 :	0	8 / 8	0.2268	0.431	0.3475	0.3475
Silver	0 :	0	8 / 8	0.0579	0.0841	0.072	0.072

TABLE 24
TISSUE EXPOSURE POINT CONCENTRATIONS - [Crayfish]

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

Analyte [1]	Site Data/Concentration [2]						EPC [3]
	Minimum SQL	Maximum SQL	Frequency of Detection	Minimum	Maximum	Arithmetic Mean	
Sodium	0 :	0	8 / 8	1934.1991	2285.9688	2111.0326	2111.03
Thallium	0.1532 :	0.1686	2 / 8	0.1951	0.2122	0.1104	0.1104
Vanadium	0 :	0	8 / 8	0.2153	0.5926	0.379	0.379
Zinc	0 :	0	8 / 8	24.0468	33.9085	28.0995	28.0995

Notes:

1 EPCs are calculated for all analytes detected in tissue; however, only the analytes identified as OHMPC in sediment were included in the food chain model.

2 Samples included in Site Data set are presented in "Data Used in Risk Assessment" Appendix.
Duplicate samples were averaged with their original samples prior to calculation of summary statistics.
The arithmetic mean represents the arithmetic average of all sample results, with one-half the reporting limit used as the value for non-detects.

3 The EPC is the arithmetic mean concentration unless the arithmetic mean concentration exceeds the maximum detected concentration (MADEP, 1995). For these OHM, the maximum detected concentration is used as the EPC.

EPC = Exposure Point Concentration

OHM = Oil or Hazardous Material

SQL = Sample Quantitation Limit

MADEP (1995): Guidance for Disposal Site Risk Characterization - In Support of the Massachusetts Contingency Plan (WSC/ORS-95-141, July).

TABLE 25
TISSUE EXPOSURE POINT CONCENTRATIONS - [Amphibians]

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

	Site Data/Concentration [2]						
Analyte [1]	Minimum SQL	Maximum SQL	Frequency of Detection	Minimum	Maximum	Arithmetic Mean	EPC [3]
SVOCs (mg/Kg)							
1,2,4-Trichlorobenzene	0.098	0.1	0				
1,2-Dichlorobenzene	0.098	0.1	0				
1,3-Dichlorobenzene	0.098	0.1	0				
1,4-Dichlorobenzene	0.098	0.1	0				
2,2'-oxybis(1-Chloropropane)	0.098	0.1	0				
2,3,6-Trichlorophenol	0.098	0.1	0				
2,4,5-Trichlorophenol	0.098	0.1	0				
2,4,6-Trichlorophenol	0.098	0.1	0				
2,4-Dichlorophenol	0.098	0.1	0				
2,4-Dimethylphenol	0.098	0.1	0				
2,4-Dinitrophenol	0.098	0.1	0				
2,4-Dinitrotoluene	0.098	0.1	0				
2,6-Dinitrotoluene	0.098	0.1	0				
2-Chloronaphthalene	0.098	0.1	0				
2-Chlorophenol	0.098	0.1	0				
2-Nitrophenol	0.098	0.1	0				
3,3'-Dichlorobenzidine	0.098	0.1	0				
4,6-Dinitro2methylphenol	0.098	0.1	0				
4-Bromophenyl-phenylether	0.098	0.1	0				
4-Chloro-3-Methylphenol	0.098	0.1	0				
4-Chlorophenylphenylether	0.098	0.1	0				
4-Nitrophenol	0.49	0.5	0				
Acenaphthene	0.098	0.1	0				
Acenaphthylene	0.098	0.1	0				
Anthracene	0.098	0.1	0				
Azobenzene	0.098	0.1	0				
Benzidine	0.098	0.1	0				

TABLE 25
TISSUE EXPOSURE POINT CONCENTRATIONS - [Amphibians]

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

	Site Data/Concentration [2]						
Analyte [1]	Minimum SQL	Maximum SQL	Frequency of Detection	Minimum	Maximum	Arithmetic Mean	EPC [3]
Benzo(a)anthracene	0.098	0.1	0				
Benzo(a)pyrene	0.098	0.1	0				
Benzo(b)fluoranthene	0.098	0.1	0				
Benzo(g,h,i)perylene	0.098	0.1	0				
Benzo(k)fluoranthene	0.098	0.1	0				
Biphenyl	0.098	0.1	0				
Butylbenzylphthalate	0.098	0.1	0				
Carbazole	0.098	0.1	0				
Chrysene	0.098	0.1	0				
Di-n-butylphthalate	0.098	0.1	0				
Di-n-octylphthalate	0.098	0.1	0				
Dibenz(a,h)anthracene	0.098	0.1	0				
Dibenzofuran	0.098	0.1	0				
Dibenzothiophene	0.098	0.1	0				
Diethylphthalate	0.098	0.1	0				
Dimethylphthalate	0.098	0.1	0				
Fluoranthene	0.098	0.1	0				
Fluorene	0.098	0.1	0				
Hexachlorobenzene	0.098	0.1	0				
Hexachlorobutadiene	0.098	0.1	0				
Hexachlorocyclopentadiene	0.098	0.1	0				
Hexachloroethane	0.098	0.1	0				
Indeno(1,2,3-cd)pyrene	0.098	0.1	0				
Isophorone	0.098	0.1	0				
N-Nitrosodimethylamine	0.098	0.1	0				
N-Nitrosodinpropylamine	0.098	0.1	0				
N-Nitrosodiphenylamine	0.098	0.1	0				
Naphthalene	0.098	0.1	0				

TABLE 25
TISSUE EXPOSURE POINT CONCENTRATIONS - [Amphibians]

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

Analyte [1]	Site Data/Concentration [2]						EPC [3]
	Minimum SQL	Maximum SQL	Frequency of Detection	Minimum	Maximum	Arithmetic Mean	
Nitrobenzene	0.098	0.1	0				
Pentachlorophenol	0.098	0.1	0				
Phenanthrene	0.098	0.1	0				
Phenol	0.098	0.1	0				
Pyrene	0.098	0.1	0				
bis(2-Chloroethyl)Ether	0.098	0.1	0				
bis(2Ethylhexyl)phthalate	0 :	0	4 / 4	0.22	23	12.305	12.305
Pesticides/PCBs (mg/Kg)							
4,4'-DDD	0.0032 :	0.0033	2 / 7	0.0015	0.0046	0.002	0.002
4,4'-DDE	0.0032 :	0.0033	5 / 7	0.0017	0.0022	0.0019	0.0019
4,4'-DDT	0.0032 :	0.0032	5 / 7	0.0028	0.0064	0.0037	0.0037
Aldrin	0.0017 :	0.0017	2 / 7	0.0018	0.0022	0.0012	0.0012
Aroclor-1016	0.032	0.032	0				
Aroclor-1221	0.066	0.066	0				
Aroclor-1232	0.032	0.032	0				
Aroclor-1242	0.032	0.032	0				
Aroclor-1248	0.032	0.032	0				
Aroclor-1254	0.032	0.032	0				
Aroclor-1260	0.032	0.032	0				
Dieldrin	0.0032	0.0033	0				
Endosulfan I	0.0017	0.0017	0				
Endosulfan II	0.0032 :	0.0033	1 / 7	0.0046	0.0046	0.002	0.002
Endosulfan sulfate	0.0032 :	0.0032	6 / 7	0.0019	0.0209	0.0093	0.0093
Endrin	0.0032 :	0.0033	2 / 7	0.0034	0.0035	0.0021	0.0021
Endrin aldehyde	0.0032 :	0.0033	2 / 7	0.0027	0.0032	0.002	0.002
Endrin ketone	0.0032	0.0033	0				
Heptachlor	0.0017	0.0017	0				
Heptachlor Epoxide	0.0017 :	0.0017	4 / 7	0.0008	0.0028	0.0012	0.0012

TABLE 25
TISSUE EXPOSURE POINT CONCENTRATIONS - [Amphibians]

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

Analyte [1]	Site Data/Concentration [2]						EPC [3]
	Minimum SQL	Maximum SQL	Frequency of Detection	Minimum	Maximum	Arithmetic Mean	
Methoxychlor	0.017 :	0.017	2 / 5	0.032	0.053	0.0221	0.0221
Toxaphene	0.17	0.17	0				
alpha-BHC	0.0017 :	0.0017	1 / 7	0.0009	0.0009	0.0009	0.0009
alpha-Chlordane	0.0017 :	0.0017	3 / 7	0.0012	0.003	0.0013	0.0013
beta-BHC	0.0017 :	0.0017	2 / 7	0.0012	0.0013	0.001	0.001
delta-BHC	0.0017	0.0017	0				
gamma-BHC (Lindane)	0.0017 :	0.0017	3 / 7	0.0011	0.0015	0.001	0.001
gamma-Chlordane	0.0017	0.0017	0				
p,p'-Methoxychlor	0.017 :	0.017	1 / 2	0.0142	0.0142	0.0114	0.0114
METALS (mg/kg)							
Aluminum	0 :	0	7 / 7	3.7872	342.5738	97.7464	97.7464
Antimony	0.1205 :	0.1607	2 / 7	0.3652	0.5055	0.175	0.175
Arsenic	0.125 :	0.2018	3 / 7	0.2224	0.3179	0.161	0.161
Barium	0 :	0	7 / 7	0.7388	4.2875	2.1408	2.1408
Beryllium	0.008 :	0.0134	2 / 7	0.0217	0.0282	0.0107	0.0107
Cadmium	0 :	0	7 / 7	0.0393	0.265	0.1559	0.1559
Calcium	0 :	0	7 / 7	1155.5	10227.906	6204.5388	6204.54
Chromium Total	0 :	0	7 / 7	0.2043	118.1857	32.4247	32.4247
Cobalt	0.0522 :	0.1027	2 / 7	0.2566	0.2699	0.0995	0.0995
Copper	0 :	0	7 / 7	2.057	4.0905	2.7282	2.7282
Iron	0 :	0	7 / 7	23.05	633.7553	199.7754	199.775
Lead	0.0924 :	0.0924	6 / 7	0.1308	0.613	0.2355	0.2355
Magnesium	0 :	0	7 / 7	105.9072	306.3	224.7602	224.76
Manganese	0 :	0	7 / 7	1.7414	31.6789	11.9369	11.9369
Mercury	0.01 :	0.01	6 / 7	0.0191	0.0776	0.0363	0.0363
Nickel	0.1004 :	0.125	3 / 7	0.1507	0.2395	0.1152	0.1152
Potassium	0 :	0	7 / 7	1297.0464	2413.5	2036.3725	2036.37
Selenium	0.1983 :	0.1983	6 / 7	0.3087	0.4817	0.3406	0.3406

TABLE 25
TISSUE EXPOSURE POINT CONCENTRATIONS - [Amphibians]

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

Analyte [1]	Site Data/Concentration [2]						EPC [3]
	Minimum SQL	Maximum SQL	Frequency of Detection	Minimum	Maximum	Arithmetic Mean	
Silver	0.0536 :	0.075	1 / 7	0.066	0.066	0.0373	0.0373
Sodium	0 :	0	7 / 7	916.5138	1413.5	1079.0348	1079.03
Thallium	0.1607	0.205	0				
Vanadium	0 :	0	7 / 7	0.0833	0.4799	0.221	0.221
Zinc	0 :	0	7 / 7	16.8153	26.235	21.2005	21.2005

Notes:

1 EPCs are calculated for all analytes detected in tissue; however, only the analytes identified as OHMPC in sediment were included in the food chain model.

2 Samples included in Site Data set are presented in "Data Used in Risk Assessment" Appendix.

Duplicate samples were averaged with their original samples prior to calculation of summary statistics.

The arithmetic mean represents the arithmetic average of all sample results, with one-half the reporting limit used as the value for non-detects.

3 The EPC is the arithmetic mean concentration unless the arithmetic mean concentration exceeds the maximum detected concentration (MADEP, 1995). For these OHM, the maximum detected concentration is used as the EPC.

EPC = Exposure Point Concentration

OHM = Oil or Hazardous Material

SQL = Sample Quantitation Limit

MADEP (1995): Guidance for Disposal Site Risk Characterization - In Support of the Massachusetts Contingency Plan (WSC/ORS-95-141, July).

TABLE 26
TISSUE EXPOSURE POINT CONCENTRATIONS - [Earthworms]

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

Analyte [1]	Minimum SQL	Maximum SQL	Site Data/Concentration [2] Frequency of Detection	Minimum	Maximum	Arithmetic Mean	EPC [3]
SVOCs (mg/Kg)							
1,2,4-Trichlorobenzene	0.33 :	0.48	0				
1,2-Dichlorobenzene	0.33 :	0.48	0				
1,3-Dichlorobenzene	0.33 :	0.48	0				
1,4-Dichlorobenzene	0.33 :	0.48	0				
2,2'-oxybis(1-Chloropropane)	0.33 :	0.48	0				
2,4,5-Trichlorophenol	1.6 :	2.3	0				
2,4,6-Trichlorophenol	0.33 :	0.48	0				
2,4-Dichlorophenol	0.33 :	0.48	0				
2,4-Dimethylphenol	0.33 :	0.48	0				
2,4-Dinitrophenol	1.6 :	2.3	0				
2,4-Dinitrotoluene	0.33 :	0.48	0				
2,6-Dinitrotoluene	0.33 :	0.48	0				
2-Chloronaphthalene	0.33 :	0.48	0				
2-Chlorophenol	0.33 :	0.48	0				
2-Methylnaphthalene	0.33 :	0.48	0				
2-Methylphenol	0.41 :	0.41	2 / 3	0.014	55	0.091	0.09
2-Nitroaniline	1.6 :	2.3	0				
2-Nitrophenol	0.33 :	0.48	0				
3,3'-Dichlorobenzidine	0.66 :	0.96	0				
3-Nitroaniline	1.6 :	2.3	0				
4,6-Dinitro-2-methylphenol	1.6 :	2.3	0				
4-Bromophenyl-phenylether	0.33 :	0.48	0				
4-Chloro-3-methylphenol	0.33 :	0.48	0				
4-Chloroaniline	0.33 :	0.48	0				
4-Chlorophenyl-phenylethene	0.33 :	0.48	0				
4-Methylphenol	0.33 :	0.41	1 / 3	0.017	0.017	0.129	0.017
4-Nitroaniline	1.6 :	2.3	0				
4-Nitrophenol	1.6 :	2.3	0				

TABLE 26
TISSUE EXPOSURE POINT CONCENTRATIONS - [Earthworms]

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

Analyte [1]	Site Data/Concentration [2]						EPC [3]
	Minimum SQL	Maximum SQL	Frequency of Detection	Minimum	Maximum	Arithmetic Mean	
Acenaphthene	0.33 :	0.48	0				
Acenaphthylene	0.33 :	0.48	0				
Anthracene	0.33 :	0.48	0				
Benzo(a)anthracene	0.33 :	0.48	0				
Benzo(a)pyrene	0.33 :	0.48	0				
Benzo(b)fluoranthene	0.33 :	0.48	0				
Benzo(g,h,i)perylene	0.33 :	0.48	0				
Benzo(k)fluoranthene	0.33 :	0.48	0				
Benzoic acid	0 :	0	3 / 3	0.56	1	0.833	0.83
Benzyl alcohol	0.33 :	0.41	1 / 3	0.041	0.041	0.137	0.041
bis(2-Chloroethoxy)methane	0.33 :	0.48	0				
bis(2-Chloroethyl)ether	0.33 :	0.48	0				
bis(2-Ethylhexyl)phthalate	0 :	0	3 / 3	0.022	2.1	0.734	0.73
Butylbenzylphthalate	0.33 :	0.48	0				
Carbazole	0.33 :	0.48	0				
Chrysene	0.33 :	0.48	0				
Di-n-butylphthalate	0.48 :	0.48	2 / 3	0.012	0.038	0.097	0.038
Di-n-octylphthalate	0.33 :	0.48	0				
Dibenzo(a,h)anthracene	0.33 :	0.48	0				
Dibenzofuran	0.33 :	0.48	0				
Diethylphthalate	0.33 :	0.48	0				
Dimethylphthalate	0.33 :	0.48	0				
Fluoranthene	0.33 :	0.48	0				
Fluorene	0.33 :	0.48	0				
Hexachlorobenzene	0.33 :	0.48	0				
Hexachlorobutadiene	0.33 :	0.48	0				
Hexachlorocyclopentadiene	0.33 :	0.48	0				
Hexachloroethane	0.33 :	0.48	0				
Indeno(1,2,3-cd)pyrene	0.33 :	0.48	0				

TABLE 26
TISSUE EXPOSURE POINT CONCENTRATIONS - [Earthworms]

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

Analyte [1]	Site Data/Concentration [2]						EPC [3]
	Minimum SQL	Maximum SQL	Frequency of Detection	Minimum	Maximum	Arithmetic Mean	
Isophorone	0.33 :	0.48	0				
N-Nitroso-di-n-propylamine	0.33 :	0.48	0				
N-Nitrosodiphenylamine	0.33 :	0.48	1 / 3	0.093	0.093	0.166	0.093
Naphthalene	0.33 :	0.48	0				
Nitrobenzene	0.33 :	0.48	0				
Pentachlorophenol	1.6 :	2.3	0				
Phenanthrene	0.33 :	0.48	0				
Phenol	0.33 :	0.48	0				
Pyrene	0.33 :	0.48	0				
Pesticides/PCBs (mg/Kg)							
4,4'-DDD	0.0033 :	0.0097	1 / 3	0.0038	0.0038	0.0034	0.0034
4,4'-DDE	0.0097 :	0.0097	2 / 3	0.0013	0.0056	0.0039	0.0039
4,4'-DDT	0 :	0	3 / 3	0.0021	0.011	0.0077	0.01
Aldrin	0.0017 :	0.005	0				
alpha-BHC	0.0017 :	0.0023	1 / 3	0.0036	0.0036	0.0019	0.0019
alpha-Chlordane	0.0017 :	0.005	0				
beta-BHC	0.0017 :	0.0023	1 / 3	0.0024	0.0024	0.0015	0.0015
delta-BHC	0 :	0	3 / 3	0.000035	0.0016	0.0007	0.0007
Dieldrin	0.0097 :	0.0097	2 / 3	0.00023	0.0097	0.002	0.0020
Endosulfan I	0.0017 :	0.005	0				
Endosulfan II	0.0033 :	0.0097	0				
Endosulfan Sulfate	0.0033 :	0.0097	0				
Endrin	0.0033 :	0.0097	0				
Endrin aldehyde	0.0033 :	0.0097	0				
Endrin ketone	0.0033 :	0.0097	0				
gamma-BHC (Lindane)	0 :	0	3 / 3	0.0084	0.017	0.0138	0.0138
gamma-Chlordane	0.0017 :	0.005	0				
Heptachlor	0.0017 :	0.005	0				
Heptachlor Epoxide	0.0017 :	0.005	0				

TABLE 26

TISSUE EXPOSURE POINT CONCENTRATIONS - [Earthworms]

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

Analyte [1]	Minimum SQL : Maximum SQL	Frequency of Detection	Site Data/Concentration [2] Minimum	Maximum	Arithmetic Mean	EPC [3]
Methoxychlor	0.017 : 0.05	0				
Toxaphene	0.033 : 0.097	0				
Metals (mg/Kg)						
Aluminum	0 : 0	3 / 3	239	841	467	467
Antimony	0.77 : 0.78	0				
Arsenic	0 : 0	3 / 3	1.1	1.6	1.43	1.43
Barium	0 : 0	3 / 3	1.9	2.5	2.17	2.17
Beryllium	0.19 : 0.2	0				
Cadmium	0 : 0	3 / 3	3.5	4	3.73	3.73
Calcium	0 : 0	3 / 3	932	1550	1171	1171
Chromium	0 : 0	3 / 3	4	44.4	26	26
Cobalt	0 : 0	3 / 3	2	2.2	2.10	2.10
Copper	0 : 0	3 / 3	1.2	1.8	1.57	1.57
Iron	0 : 0	3 / 3	329	801	554	554
Lead	0 : 0	3 / 3	1.9	3.2	2.70	2.70
Magnesium	0 : 0	3 / 3	114	248	181	181
Manganese	0 : 0	3 / 3	2	6.4	3.63	3.63
Mercury	0.1 : 0.1	2 / 3	0.1	0.9	0.36	0.36
Nickel	0 : 0	3 / 3	0.48	0.88	0.66	0.66
Potassium	0 : 0	3 / 3	764	856	821	821
Selenium	0 : 0	3 / 3	2.6	3.5	2.93	2.93
Silver	0.19 : 0.2	0				
Sodium	0 : 0	3 / 3	797	920	866	866
Thallium	0.38 : 0.39	0				
Vanadium	0 : 0	3 / 3	0.91	1.6	1.20	1.20
Zinc	0 : 0	3 / 3	64.8	115	93	93

Notes:

1 EPCs are calculated for all analytes detected in tissue; however, only the analytes identified as OHMPC in surface soil were included in the food chain model.

TABLE 26
TISSUE EXPOSURE POINT CONCENTRATIONS - [Earthworms]

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

Analyte [1]	Site Data/Concentration [2]						EPC [3]
	Minimum SQL	Maximum SQL	Frequency of Detection	Minimum	Maximum	Arithmetic Mean	

2 Samples included in Site Data set are presented in "Data Used in Risk Assessment" Appendix.
Duplicate samples were averaged with their original samples prior to calculation of summary statistics.
The arithmetic mean represents the arithmetic average of all sample results, with one-half the reporting limit used as the value for non-detects.
3 The EPC is the arithmetic mean concentration unless the arithmetic mean concentration exceeds the maximum detected concentration (MADEP, 1995). For these OHM, the maximum detected concentration is used as the EPC.
EPC = Exposure Point Concentration
OHM = Oil or Hazardous Material
SQL = Sample Quantitation Limit
MADEP (1995): Guidance for Disposal Site Risk Characterization - In Support of the Massachusetts Contingency Plan (WSC/ORS-95-141, July).

TABLE 27
SUMMARY OF SURVIVAL DATA FOR AFRICAN CLAWED FROG (*Xenopus laevis*)

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

Sample Location/ Sample Number	Number Organisms (25 Eggs at 0 Hr)		Mean Survival	Survival Significantly Different From	
				Lab Control	Reference Site
Laboratory Control	22	23	90.0%		NO
BS012REFXX Reference Site	20	20	80.0%	NO	
BS005WDXXX	15	11	52.0%	YES	YES
BS006WDXXX	10	7	34.0%	YES	YES
BS007WDOXX	16	18	68.0%	NO	NO
BS008SDXXX	19	20	78.0%	NO	NO
BS009PNDXX	14	16	60.0%	YES	NO
BS010PNDXX	22	17	78.0%	NO	NO
BS011WMDXX	22	16	76.0%	NO	NO

Olin Chemical Company Site Sediment Toxicity Evaluation, January 1997.
ESI Study Number 6244.

From: ESI, 1997.

TABLE 28
SUMMARY OF MALFORMATION DATA FOR AFRICAN CLAWED FROG *(Xenopus laevis)*

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

Sample Location/ Sample Number	Percent of Organisms With Normal Development		Mean Percent Normal	Development Significantly Different From	
				Lab Control	Reference Site
Laboratory Control	88.0	76.0	82.0%		NO
BS012REFXX Reference Site	60.0	56.0	58.0%	NO	
BS005WDXXX	16.0	4.0	10.0%	YES	YES
BS006WDXXX	0.0	0.0	0.0%	YES	YES
BS007WDOXX	36.0	40.0	38.0%	YES	NO
BS008SDXXX	60.0	52.0	56.0%	NO	NO
BS009PNDXX	48.0	24.0	36.0%	YES	NO
BS010PNDXX	40.0	48.0	44.0%	YES	NO
BS011WMDXX	72.0	60.0	66.0%	NO	NO

Olin Chemical Company Site Sediment Toxicity Evaluation, January 1997.
ESI Study Number 6244.

From: ESI, 1997.

TABLE 29
SUMMARY OF LC-50, ASSOCIATED ENDPOINTS, AND DATA SUMMARIES FOR ACUTE DEFINITIVE ASSAYS USING AFRICAN CLAWED FROG (*Xenopus laevis*)

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

ELUTRIATE CONCENTRATION

SITE	Control	6.25%	12.5%	25.0%	50.0%	100.0%
SUMMARY OF SURVIVAL DATA (% Survival at 96 Hours)						
BS005WDXXX	100.0	60.0	70.0	73.3	70.0	76.7
BS006WDXXX	100.0	93.3	56.7	63.3	56.7	53.3
BS009PNDXX	100.0	83.3	66.7	93.3	53.3	33.3

SITE	Control	6.25%	12.5%	25.0%	50.0%	100.0%
SUMMARY OF DEVELOPMENTAL DATA (% Normal Development at 96 Hours)						
BS005WDXXX	83.3	46.7	36.7	33.3	23.3	40.0
BS006WDXXX	83.3	66.7	26.7	26.7	30.0	10.0
BS009PNDXX	83.3	46.7	46.7	63.3	20.0	20.0

Sample Location/ Sample Number	LC-50 (Survival)	EC-50 (Development)	IC-25 (Development)	IC-50 (Development)	ANOEC (Development)
BS005WDXXX	>100%	9.30%	3.65%	9.38%	<6.25
BS006WDXXX	86.23%	15.14%	7.52%	10.16%	6.25%
BS009PNDXX	69.58%	24.66%	4.21%	33.39%	<6.25%

Olin Chemical Company Site Sediment Toxicity Evaluation, January 1997.
ESI Study Number 6244.

From: ESI, 1997.

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TABLE 30
SUMMARY OF TOXICITY DATA FOR AMPHIBIAN RECEPTORS

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

Chemical Name	Species Identification (Organism)	Age/Life Stage	Exposure Regimen	Effects Concentration	Effect	Source
VOLATILE ORGANIC COMPOUNDS						
Acetone	Ambystoma mexicanum; Axolotl	3-4 weeks	48 h	20,000 mg/L	LC_{50}	Devillers & Exbrayat, 1992
	Ambystoma mexicanum; Axolotl	3-4 weeks	48 h	12,000 mg/L	NOLC	Devillers & Exbrayat, 1992
	Xenopus laevis; Clawed toad	3-4 weeks	48 h	24,000 mg/L	LC_{50}	Devillers & Exbrayat, 1992
	Xenopus laevis; Clawed toad	3-4 weeks	48 h	20,000 mg/L	NOLC	Devillers & Exbrayat, 1992
	Quantitative Structure-Activity Relationship [a]	NA	NA	18,000 mg/L	Narcosis	Lipnick, R.L., 1989
Benzene	Ambystoma mexicanum; Axolotl	3-4 weeks	48 h	370 mg/L	LC_{50}	Devillers & Exbrayat, 1992
	Ambystoma mexicanum; Axolotl	3-4 weeks	48 h	120 mg/L	NOLC	Devillers & Exbrayat, 1992
	Ambystoma gracile;Northwestern Salamander	Embryo/Larva	96h	5.21 mg/L	LC_{50}	Black et al., 1982
	Rana pipiens; Northern leopard frog	Embryo/Larva	96 h [b]	3.66 mg/L	LC_{50}	Devillers & Exbrayat, 1992
	Xenopus laevis; Clawed toad	3-4 weeks	48 h	190 mg/L	LC_{50}	Devillers & Exbrayat, 1992
	Xenopus laevis; Clawed toad	3-4 weeks	48 h	105 mg/L	NOLC	Devillers & Exbrayat, 1992
	Quantitative Structure-Activity Relationship [a]	NA	NA	180 mg/L	Narcosis	Lipnick, R.L., 1989
Bromoform	Quantitative Structure-Activity Relationship [a]	NA	NA	720 mg/L	Narcosis	Lipnick, R.L., 1989
Carbon Tetrachloride	Rana pipiens; Northern leopard frog	Embryo/Larva	96 h [b]	1.64 mg/L	LC_{50}	Devillers & Exbrayat, 1992
	Rana temporaria; Common/Grass frog	Embryo/Larva	96h	1.16 mg/L	LC_{50}	Black et al., 1982
	Ambystoma mexicanum; Axolotl	Embryo/Larva	96h	1.98 mg/L	LC_{50}	Black et al., 1982
	Rana palustris; Pickerel frog	Embryo/Larva	96h	2.37 mg/L	LC_{50}	Black et al., 1982
	Bufo woodhousei fowleri; Fowler's toad	Embryo/Larva	96h	2.83 mg/L	LC_{50}	Black et al., 1982
	Xenopus laevis; Clawed toad	Embryo/Larva	96h	22.42 mg/L	LC_{50}	Black et al., 1982
	Quantitative Structure-Activity Relationship [a]	NA	NA	80 mg/L	Narcosis	Lipnick, R.L., 1989
Chlorobenzene	Rana pipiens; Northern leopard frog	Embryo/Larva	96 h [b]	1.2 mg/L	LC_{50}	Devillers & Exbrayat, 1992
	Ambystoma gracile;Northwestern Salamander	Embryo/Larva	96h	1.15 mg/L	LC_{50}	Black et al., 1982
	Quantitative Structure-Activity Relationship [a]	NA	NA	59 mg/L	Narcosis	Lipnick, R.L., 1989
Chloroform	Rana pipiens; Northern leopard frog	Embryo/Larva	96 h [b]	4.16 mg/L	LC_{50}	Devillers & Exbrayat, 1992
	Quantitative Structure-Activity Relationship [a]	NA	NA	340 mg/L	Narcosis	Lipnick, R.L., 1989
Dichloromethane	Rana pipiens; Northern leopard frog	Embryo/Larva	96 h [b]	>48 mg/L	LC_{50}	Devillers & Exbrayat, 1992
	Quantitative Structure-Activity Relationship [a]	NA	NA	1000 mg/L	Narcosis	Lipnick, R.L., 1989
Toluene	Rana pipiens; Northern leopard frog	Embryo/Larva	96 h [b]	0.39 mg/L	LC_{50}	Devillers & Exbrayat, 1992
	Quantitative Structure-Activity Relationship [a]	NA	NA	61 mg/L	Narcosis	Lipnick, R.L., 1989
Trichloroethylene	Ambystoma mexicanum; Axolotl	3-4 weeks	48 h	48 mg/L	LC_{50}	Devillers & Exbrayat, 1992
	Ambystoma mexicanum; Axolotl	3-4 weeks	48 h	29 mg/L	NOLC	Devillers & Exbrayat, 1992
	Xenopus laevis; Clawed toad	3-4 weeks	48 h	45 mg/L	LC_{50}	Devillers & Exbrayat, 1992
	Xenopus laevis; Clawed toad	3-4 weeks	48 h	41 mg/L	NOLC	Devillers & Exbrayat, 1992
	Quantitative Structure-Activity Relationship [a]	NA	NA	160 mg/L	Narcosis	Lipnick, R.L., 1989
o-Xylene	Xenopus laevis; Clawed toad	3-4 weeks	48 h	73 mg/L	LC_{50}	Devillers & Exbrayat, 1992
	Quantitative Structure-Activity Relationship [a]	NA	NA	25 mg/L	Narcosis	Lipnick, R.L., 1989

TABLE 30
SUMMARY OF TOXICITY DATA FOR AMPHIBIAN RECEPTORS

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

Chemical Name	Species Identification (Organism)	Age/Life Stage	Exposure Regimen	Effects Concentration	Effect	Source
SEMI-VOLATILE ORGANIC COMPOUNDS						
1,2-Dibromomethane	Pleurodeles walti; Iberian ribbed newt	Larvae, 32 mm	12 d	1 to 5 mg/L	Cytogenetic effects	AQUIRE; 219976
	Quantitative Structure-Activity Relationship [a]	NA	NA	540 mg/L	Narcosis	Lipnick, R.L., 1989
2-Proponone	Ambystoma mexicanum; Axolotl	3-4 weeks	48 h	20,000 mg/L	LC_{50}	AQUIRE; 219740
	Quantitative Structure-Activity Relationship [a]	NA	NA	18,000 mg/L	Narcosis	Lipnick, R.L., 1989
4-Chloroaniline	Xenopus laevis; Clawed toad	Egg stage	3 wk	100 mg/L	Lethality	AQUIRE; 212617
	Xenopus laevis; Clawed toad	Egg stage	3 wk	0.001 mg/L	32% Mortality	AQUIRE; 212617
	Quantitative Structure-Activity Relationship [a]	NA	NA	560 mg/L	Narcosis	Lipnick, R.L., 1989
Anthracene	Rana pipiens; Northern leopard frog	Embryo	24 h [c]	0.065 mg/L	LC_{50}	Devillers & Exbrayat, 1992
	Rana pipiens; Northern leopard frog	Embryo	24 h [c]	0.11 mg/L	LC_{50}	Devillers & Exbrayat, 1992
	Rana pipiens; Northern leopard frog	NA	24 h [d]	0.025 mg/L	LC_{50}	ECOTOX
	Quantitative Structure-Activity Relationship [a]	NA	NA	2.7 mg/L	Narcosis	Lipnick, R.L., 1989
Benzo(a)pyrene	Pleurodeles walti; Iberian ribbed newt	Larva (3-4 cm)	8 d	0.01 mg/L	TDL0	Devillers & Exbrayat, 1992
	Pleurodeles walti; Iberian ribbed newt	Larva (3-4 cm)	48 h	0.20 mg/L	physiochemical	AQUIRE
	Bufo americanus; American toad	NA	24 h	5.0 mg/L	Change in lnth and/or wt	AQUIRE
	Rana pipiens; Northern leopard frog	NA	24 h	5.0 mg/L	Change in lnth and/or wt	AQUIRE
	Quantitative Structure-Activity Relationship [a]	NA	NA	0.16 mg/L	Narcosis	Lipnick, R.L., 1989
Bis(2-ethylhexyl)phthalate	Bufo woodhousei fowleri; Fowler's toad	Embryo to larva	to 8 d	3.880 mg/L	LC_{50}	AQUIRE; 216772
	Bufo woodhousei fowleri; Fowler's toad	Larva	96 h	3.880 mg/L	LC_{50}	AQUIRE; 216772
	Quantitative Structure-Activity Relationship [a]	NA	NA	1.7 mg/L	Narcosis	Lipnick, R.L., 1989
Di-n-octylphthalate	Quantitative Structure-Activity Relationship [a]	NA	NA	0.0032mg/L	Narcosis	Lipnick, R.L., 1989
Fluoranthene	Rana pipiens; Northern leopard frog	Embryo	24 h [c]	0.09 mg/L	LC_{50}	Devillers & Exbrayat, 1992
	Quantitative Structure-Activity Relationship [a]	NA	NA	1.2 mg/L	Narcosis	Lipnick, R.L., 1989
Naphthalene	Xenopus laevis; Clawed toad	Larva (3 wks)	96 h	2.1 mg/L	LC_{50}	Devillers & Exbrayat, 1992
	Xenopus laevis; Clawed toad	Larva (3 wks)	6 h	3.7 mg/L	EC_{50}	Devillers & Exbrayat, 1992
	Xenopus laevis; Clawed toad	Larva (3 wks)	6 h	2.3 mg/L	EC_{50}	Devillers & Exbrayat, 1992
	Xenopus laevis; Clawed toad	Larva (3 wks)	~2 h	4.5 mg/L	Mortality	Devillers & Exbrayat, 1992
	Quantitative Structure-Activity Relationship [a]	NA	NA	13 mg/L	Narcosis	Lipnick, R.L., 1989
Nitrobenzene	Rana pipiens; Northern leopard frog	Embryo/Larva	96 h [b]	0.64 mg/L	LC_{50}	Devillers & Exbrayat, 1992
	Quantitative Structure-Activity Relationship [a]	NA	NA	420 mg/L	Narcosis	Lipnick, R.L., 1989
N-Nitrosodiphenylamine	Quantitative Structure-Activity Relationship [a]	NA	NA	57 mg/L	Narcosis	Lipnick, R.L., 1989
Pentachlorophenol	Ambystoma mexicanum; Axolotl	3-4 weeks	48 h	0.3 mg/L	LC_{50}	Devillers & Exbrayat, 1992
	Ambystoma mexicanum; Axolotl	3-4 weeks	48 h	0.13 mg/L	NOLC	Devillers & Exbrayat, 1992
	Rana catesbeiana; Bullfrog	Tadpole	96 h	0.207 mg/L	LC_{50}	Devillers & Exbrayat, 1992

TABLE 30
SUMMARY OF TOXICITY DATA FOR AMPHIBIAN RECEPTORS

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

Chemical Name	Species Identification (Organism)	Age/Life Stage	Exposure Regimen	Effects Concentration	Effect	Source
	Xenopus laevis; Clawed toad	3-4 weeks	48 h	0.26 mg/L	LC_{50}	Devillers & Exbrayat, 1992
	Xenopus laevis; Clawed toad	3-4 weeks	48 h	0.21 mg/L	NOLC	Devillers & Exbrayat, 1992
	Xenopus laevis; Clawed toad	< 2 days	100 d	0.032 mg/L	NOLC	Devillers & Exbrayat, 1992
	Quantitative Structure-Activity Relationship [a]	NA	NA	0.22 mg/L	Narcosis	Lipnick, R.L., 1989
Phenol	Ambystoma gracile;Northwestern Salamander	Embryo/Larva	96h	0.38 mg/L	LC_{50}	Black et al., 1982
	Bufo fowleri; Fowler's toad	Embryo/Larva	96h	2.45 mg/L	LC_{50}	Black et al., 1982
	Rana pipiens; Northern leopard frog	Embryo/Larva	96 h [b]	0.04 mg/L	LC_{50}	Devillers & Exbrayat, 1992
	Rana palustris;Pickerel frog	Embryo/Larva	96h	9.87 mg/L	LC_{50}	Black et al., 1982
	Rana temporaria; Common/Grass frog	Embryo/Larva	96h	0.27 mg/L	LC_{50}	Black et al., 1982
	Xenopus laevis; Clawed toad	Embryo/Larva	96h	7.68 mg/L	LC_{50}	Black et al., 1982
	Xenopus laevis; Clawed toad	Embryo/Larva	96h	51.1 mg/L	LC_{50}	Holcombe et al., 1987
	Quantitative Structure-Activity Relationship [a]	NA	NA	760 mg/L	Narcosis	Lipnick, R.L., 1989
Pyrene	Rana pipiens; Northern leopard frog	Embryo	24 h [c]	0.14 mg/L	LC_{50}	Devillers & Exbrayat, 1992
	Pleurodeles waltl; Iberian ribbed newt	Larvae, 32 mm	12 d	0.035 to 0.2 (F) mg/L	Cytogenetic effects	AQUIRE; 219976
	Quantitative Structure-Activity Relationship [a]	NA	NA	0.57 mg/L	Narcosis	Lipnick, R.L., 1989
PESTICIDES/PCBs						
4,4'-DDD	Bufo woodhousei fowleri; Fowler's toad	Tadpole	96 h	0.140 mg/L	LC_{50}	Devillers & Exbrayat, 1992
	Bufo woodhousei fowleri; Fowler's toad	Tadpole	24 h	0.709 mg/L	LC_{50}	ECOTOX
4,4'-DDT	Bufo woodhousei fowleri; Fowler's toad	Tadpole 6 wks	96 h	0.10 mg/L	LC_{50}	Devillers & Exbrayat, 1992
	Bufo woodhousei fowleri; Fowler's toad	Tadpole 7 wks	96 h	0.03 mg/L	LC_{50}	Devillers & Exbrayat, 1992
	Rana temporaria; Common/Grass frog	Adults	20 d	7.6 mg/kg (dose)	LD_{50}	Devillers & Exbrayat, 1992
Aldrin	Bufo woodhousei fowleri; Fowler's toad	Tadpole	96 h	0.068 mg/L	LC_{50}	Devillers & Exbrayat, 1992
	Rana pipiens; Northern leopard frog	3.5 in/ 65 g	30 d	0.30 mg/L	40% Mortality	Devillers & Exbrayat, 1992
Aroclor 1242	Bufo americanus; American toad	Embryo/Larva	96 h [b]	0.00271 mg/L	LC_{50}	Devillers & Exbrayat, 1992
	Bufo fowleri; Fowler's toad	Embryo/Larva	96 h [b]	0.01209 mg/L	LC_{50}	Devillers & Exbrayat, 1992
Aroclor 1254	Bufo americanus; American toad	Embryo/Larva	96 h [b]	0.00202 mg/L	LC_{50}	AQUIRE; 216772
	Bufo fowleri; Fowler's toad	Embryo/Larva	96 h [b]	0.00374 mg/L	LC_{50}	AQUIRE; 216772
	Pleurodeles waltl; Iberian ribbed newt	Larvae, 32 mm	12 d	0.025 to 0.050 mg/L	Cytogenetic effects	AQUIRE; 219976
	Bufo woodhousei fowleri; Fowler's toad	Egg, 2-6 h	7 to 96 h	0.03818 mg/L	LC_{50}	AQUIRE; 216772
	Bufo americanus; American toad	Egg, 2-6 h	7 to 96 h	0.01032 mg/L	LC_{50}	AQUIRE; 216772
	Bufo woodhousei fowleri; Fowler's toad	Embryo to larva	to 8 d	0.00374 mg/L	LC_{50}	AQUIRE; 216772
	Bufo americanus; American toad	Embryo to larva	to 8 d	0.00202 mg/L	LC_{50}	AQUIRE; 216772
gamma-BHC (Lindane)	Bufo woodhousei fowleri; Fowler's toad	Tadpole	96 h	3.2 mg/L	LC_{50}	Devillers & Exbrayat, 1992
	Microhyla ornata; Ornate chorus frog	Yolk plug-stage	96 h	23.37 mg/L	LC_{50}	Devillers & Exbrayat, 1992
	Microhyla ornata; Ornate chorus frog	Tadpole, 8d	96 h	7.270 mg/L	LC_{50}	Devillers & Exbrayat, 1992
	Microhyla ornata; Ornate chorus frog	Yolk plug-stage	96 h	20 mg/L	47% Mortality	Devillers & Exbrayat, 1992
	Microhyla ornata; Ornate chorus frog	Yolk plug-stage	48 h	20 mg/L	52% Hatch abnormality	Devillers & Exbrayat, 1992
	Microhyla ornata; Ornate chorus frog	Yolk plug-stage	96 h	10 mg/L	12.5% Hatch abnormality	Devillers & Exbrayat, 1992

TABLE 30
SUMMARY OF TOXICITY DATA FOR AMPHIBIAN RECEPTORS

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

Chemical Name	Species Identification (Organism)	Age/Life Stage	Exposure Regimen	Effects Concentration	Effect	Source
	Pseudacris triseriata; Chorus frog	tadpole	96 h	2.65 mg/L	LC_{50}	Devillers & Exbrayat, 1992
Chlordane	Rana pipiens; Northern leopard frog	3.5in / 65 g	30 d	0.50 mg/L	40% Mortality	Devillers & Exbrayat, 1992
	Rana pipiens; Northern leopard frog	65 g	30 d	<0.38 mg/L	Mortality	ECOTOX
Dieldrin	Bufo woodhousei fowleri; Fowler's toad	Tadpole	96 h	0.15 mg/L	LC_{50}	Devillers & Exbrayat, 1992
	Pseudacris triseriata; Chorus frog	Tadpole	96 h	0.10 mg/L	LC_{50}	Devillers & Exbrayat, 1992
	Rana pipiens; Northern leopard frog	3.5in / 65 g	30 d	0.10 mg/L	50% Mortality	Devillers & Exbrayat, 1992
Endrin	Acris crepitans; Cricket frog	Larva	96 h [e]	0.010 mg/L	LC_{50}	Devillers & Exbrayat, 1992
	Acris crepitans; Cricket frog	Larva	24 h	0.023 mg/L	EC_{50}	ECOTOX
	Ambystoma maculatum; Spotted salamander	Larva	96 h [e]	0.056 mg/L	LC_{50}	Devillers & Exbrayat, 1992
	Ambystoma maculatum; Spotted salamander	Larva	24 h	0.048 mg/L	EC_{50}	ECOTOX
	Ambystoma opacum; Marbled salamander	Larva	96 h [e]	0.018 mg/L	LC_{50}	Devillers & Exbrayat, 1992
	Ambystoma opacum; Marbled salamander	Larva	24 h	0.018 mg/L	EC_{50}	ECOTOX
	Bufo americanus; American toad	Larva	96 h [e]	0.010 mg/L	LC_{50}	Devillers & Exbrayat, 1992
	Bufo americanus; American toad	Larva	24 h	0.008 mg/L	EC_{50}	ECOTOX
	Bufo woodhousei fowleri; Fowler's toad	Tadpole	96 h	0.12 mg/L	LC_{50}	Devillers & Exbrayat, 1992
	Pseudacris triseriata; Chorus frog	Tadpole	96 h [e]	0.18 mg/L	LC_{50}	Devillers & Exbrayat, 1992
	Pseudacris triseriata; Chorus frog	Tadpole	24 h	0.29 mg/L	LC_{50}	ECOTOX
	Rana catesbeiana; Bullfrog	Larva	96 h [e]	0.002 mg/L	LC_{50}	Devillers & Exbrayat, 1992
	Rana catesbeiana; Bullfrog	Larva	24 h	>0.040 mg/L	EC_{50}	ECOTOX
	Rana catesbeiana; Bullfrog	Tadpole	96 h	0.0025 mg/L	LC_{50}	Devillers & Exbrayat, 1992
	Rana pipiens; Northern leopard frog	3.5 in / 65 g	30 d	0.03 mg/L	30% Mortality	Devillers & Exbrayat, 1992
	Rana sphenocephala; Southern leopard frog	Egg	24 h	0.025 mg/L	LC_{50}	Devillers & Exbrayat, 1992
	Rana sphenocephala; Southern leopard frog	Young larva	96 h	0.006 mg/L	LC_{50}	Devillers & Exbrayat, 1992
	Rana sphenocephala; Southern leopard frog	Older larva	96 h	0.006 mg/L	LC_{50}	Devillers & Exbrayat, 1992
	Rana sphenocephala; Southern leopard frog	Sub-adult	96 h	0.005 mg/L	LC_{50}	Devillers & Exbrayat, 1992
	Rana sphenocephala; Southern leopard frog	Larva	96 h [e]	0.009 mg/L	LC_{50}	Devillers & Exbrayat, 1992
	Rana sphenocephala; Southern leopard frog	Larva	24 h	0.013 mg/L	EC_{50}	ECOTOX
	Rana sylvatica; Wood frog	Larva	96 h [e]	0.034 mg/L	LC_{50}	Devillers & Exbrayat, 1992
	Rana sylvatica; Wood frog	Larva	24 h	<0.016 mg/L	EC_{50}	ECOTOX
	Rana pipiens; Northern leopard frog	*65 g*	*30 d*	*<0.02 mg/L*	*Mortality*	*ECOTOX*
Heptachlor	Bufo woodhousei fowleri; Fowler's toad	Tadpole	96 h	0.435 mg/L	LC_{50}	Devillers & Exbrayat, 1992
	Bufo woodhousei fowleri; Fowler's toad	Tadpole	24 h	0.844 mg/L	LC_{50}	ECOTOX
Methoxychlor	Bufo woodhousei fowleri; Fowler's toad	Tadpole 4-5 wks	48 h	0.100 mg/L	LC_{50}	Devillers & Exbrayat, 1992
	Bufo woodhousei fowleri; Fowler's toad	Tadpole 4-5 wks	24 h	0.76 mg/L	LC_{50}	AQUIRE
	Bufo woodhousei fowleri; Fowler's toad	Tadpole 4-5 wks	48 h	0.11 mg/L	LC_{50}	AQUIRE
	Pseudacris triseriata; Chorus frog	NA	24 h	0.44 mg/L	LC_{50}	AQUIRE
	Pseudacris triseriata; Chorus frog	NA	48 h	0.42 mg/L	LC_{50}	AQUIRE
	Pseudacris triseriata; Chorus frog	NA	96 h	0.33 mg/L	LC_{50}	AQUIRE
Toxaphene	Acris crepitans; Northern cricket frog	Larva	96 h [e]	0.076 mg/L	LC_{50}	Devillers & Exbrayat, 1992
	Ambystoma maculatum; Spotted salamander	Larva	96 h [e]	0.034 mg/L	LC_{50}	Devillers & Exbrayat, 1992
	Ambystoma opacum; Marbled salamander	Larva	96 h [e]	0.342 mg/L	LC_{50}	Devillers & Exbrayat, 1992

TABLE 30
SUMMARY OF TOXICITY DATA FOR AMPHIBIAN RECEPTORS

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

Chemical Name	Species Identification (Organism)	Age/Life Stage	Exposure Regimen	Effects Concentration	Effect	Source
	Bufo americanus; American toad	Larva	96 h [e]	0.034 mg/L	LC_{50}	Devillers & Exbrayat, 1992
	Bufo woodhousei fowleri; Fowler's toad	Tadpole	96 h [e]	0.150 mg/L	LC_{50}	Devillers & Exbrayat, 1992
	Pseudacris triseriata; Chorus frog	Tadpole	96 h	0.390 mg/L	LC_{50}	Devillers & Exbrayat, 1992
	Rana catesbeiana; Bullfrog	Larva	96 h [e]	0.099 mg/L	LC_{50}	Devillers & Exbrayat, 1992
	Rana pipiens; Northern leopard frog	3.5 in / 63 g	30 d	0.060 mg/L	25% Mortality	Devillers & Exbrayat, 1992
	Rana sphenocephala; Southern leopard frog	Egg	96 h	0.060 mg/L	LC_{50}	Devillers & Exbrayat, 1992
	Rana sphenocephala; Southern leopard frog	Egg	96 h	0.046 mg/L	LC_{50}	Devillers & Exbrayat, 1992
	Rana sphenocephala; Southern leopard frog	Young larva	96 h	0.168 mg/L	LC_{50}	Devillers & Exbrayat, 1992
	Rana sphenocephala; Southern leopard frog	Young larva	96 h	0.065 mg/L	LC_{50}	Devillers & Exbrayat, 1992
	Rana sphenocephala; Southern leopard frog	Young larva	96 h	0.032 mg/L	LC_{50}	Devillers & Exbrayat, 1992
	Rana sphenocephala; Southern leopard frog	Sub-adult	96 h	0.378 mg/L	LC_{50}	Devillers & Exbrayat, 1992
	Rana sphenocephala; Southern leopard frog	Larva	96 h [e]	0.130 mg/L	LC_{50}	Devillers & Exbrayat, 1992
	Rana sylvatica; Wood frog	Larva	96 h [e]	0.195 mg/L	LC_{50}	Devillers & Exbrayat, 1992
INORGANIC COMPOUNDS						
Aluminum	Bufo americanus; American toad	Tadpole	96 h	0.627 mg/L	LC_{50}	Devillers & Exbrayat, 1992
	Bufo americanus; American toad	Tadpole	96 h	0.859 mg/L	LC_{50}	Devillers & Exbrayat, 1992
	Bufo americanus; American toad	Tadpole	96 h	1.379 mg/L	LC_{50}	Devillers & Exbrayat, 1992
	Bufo americanus; American toad	Tadpole	96 h	1.663 mg/L	LC_{50}	Devillers & Exbrayat, 1992
	Bufo americanus; American toad	Tadpole	96 h	>1.762 mg/L	LC_{50}	Devillers & Exbrayat, 1992
	Rana pipiens; Northern leopard frog	Embryo	96 h	0.811 mg/L	LC_{50}	Devillers & Exbrayat, 1992
	Rana pipiens; Northern leopard frog	Embryo	96 h	0.403 mg/L	LC_{50}	Devillers & Exbrayat, 1992
	Rana pipiens; Northern leopard frog	Embryo	96 h	>0.856 mg/L	LC_{50}	Devillers & Exbrayat, 1992
	Rana pipiens; Northern leopard frog	Embryo	96 h	>1 mg/L	LC_{50}	Devillers & Exbrayat, 1992
	Rana pipiens; Northern leopard frog	Embryo	96 h	>0.980 mg/L	LC_{50}	Devillers & Exbrayat, 1992
	Rana pipiens; Northern leopard frog	Embryo	96 h	>1.018 mg/L	LC_{50}	Devillers & Exbrayat, 1992
	Rana pipiens; Northern leopard frog	Embryo	96 h	0.471 mg/L	LC_{50}	ECOTOX
Aluminum chloride	Microhyla carolinensis; Narrow mouthed frog	Eggs	7 d	0.050 mg/L	LC_{50}	AQUIRE; 215305
	Ambystoma opacum; Marbled salamander	Eggs	8 d	2.28 mg/L	LC_{50}	AQUIRE; 216199
Beryllium Sulfate	Ambystoma maculatum; Spotted salamander	Larva	24, 48, and 9	31.5 mg/L Be	TL_{50}	Devillers & Exbrayat, 1992
	Ambystoma maculatum; Spotted salamander	Larva	96 h	3.15 mg/L Be	TL_{50}	Devillers & Exbrayat, 1992
	Ambystoma maculatum; Spotted salamander	Larva	24, 48, and 9	18.2 mg/L Be	TL_{50}	Devillers & Exbrayat, 1992
	Ambystoma maculatum; Spotted salamander	Larva	96 h	8.02 mg/L Be	TL_{50}	Devillers & Exbrayat, 1992
	Ambystoma maculatum; Spotted salamander	Larva	48 and 96 h	18.2 mg/L Be	TL_{50}	Devillers & Exbrayat, 1992
	Ambystoma maculatum; Spotted salamander	Larva	96 h	8.32 mg/L Be	TL_{50}	Devillers & Exbrayat, 1992
	Ambystoma maculatum; Spotted salamander	Larva	24 h	6.83 mg/L Be	TL_{50}	ECOTOX
	Ambystoma maculatum; Spotted salamander	Larva	48 h	4.21 mg/L BE	LC_{50}	ECOTOX
	Ambystoma maculatum; Spotted salamander	Larva	24 and 48 h	>10 mg/L Be	TL_{50}	ECOTOX
	Ambystoma maculatum; Spotted salamander	Larva	24 h	21.2 mg/L	TL_{50}	ECOTOX
	Ambystoma opacum; Marbled salamander	Larva	24, 48, and 9	31.5 mg/L Be	TL_{50}	Devillers & Exbrayat, 1992
	Ambystoma opacum; Marbled salamander	Larva	96 h	3.15 mg/L Be	TL_{50}	Devillers & Exbrayat, 1992
	Ambystoma opacum; Marbled salamander	Larva	24 h	23.7 mg/L Be	TL_{50}	ECOTOX
	Ambystoma opacum; Marbled salamander	Larva	48 h	4.21 mg/L Be	TL_{50}	ECOTOX
Cadmium Acetate	Notophthalmus viridescens; Eastern newt	NA	25 d	3.5 mg/L	Mortality	AQUIRE

TABLE 30
SUMMARY OF TOXICITY DATA FOR AMPHIBIAN RECEPTORS

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

Chemical Name	Species Identification (Organism)	Age/Life Stage	Exposure Regimen	Effects Concentration	Effect	Source
	Notophthalmus viridescens; Eastern newt	NA	25 d	4.0 mg/L	Mortality	AQUIRE
	Notophthalmus viridescens; Eastern newt	NA	25 d	4.5 mg/L	Mortality	AQUIRE
	Notophthalmus viridescens; Eastern newt	NA	25 d	2.0 mg/L	Mortality	AQUIRE
	Notophthalmus viridescens; Eastern newt	NA	25 d	2.5 mg/L	Mortality	AQUIRE
	Notophthalmus viridescens; Eastern newt	NA	25 d	3.0 mg/L	Mortality	AQUIRE
	Notophthalmus viridescens; Eastern newt	NA	51 d	2.25 mg/L	Mortality	AQUIRE
	Notophthalmus viridescens; Eastern newt	NA	51 d	4.5 mg/L	Mortality	AQUIRE
	Notophthalmus viridescens; Eastern newt	NA	51 d	6.75 mg/L	Mortality	AQUIRE
	Notophthalmus viridescens; Eastern newt	NA	60 d	2.0 mg/L	Regeneration capabilities	AQUIRE
	Notophthalmus viridescens; Eastern newt	NA	76 d	2.25 mg/L	Regeneration capabilities	AQUIRE
Cadimum Chloride	Xenopus laevis; Clawed toad	3-4 weeks	48 h	3.2 mg/L Cd^{2+}	LC_{50}	Devillers & Exbrayat, 1992
	Xenopus laevis; Clawed toad	2 days	100 d	1.5 mg/L Cd^{2+}	LC_{50}	Devillers & Exbrayat, 1992
	Ambystoma opacum; Marbled salamander	NA	8 d	0.15 mg/L	LC_{50}	AQUIRE
	Bufo arenarum; Argentine toad	NA	24 h	3.41 mg/L	LC_{50}	AQUIRE
	Bufo arenarum; Argentine toad	NA	24 h	4.05 mg/L	LC_{50}	AQUIRE
	Bufo arenarum; Argentine toad	NA	24 h	4.76 mg/L	LC_{50}	AQUIRE
	Bufo arenarum; Argentine toad	NA	24 h	9.92 mg/L	LC_{50}	AQUIRE
	Bufo arenarum; Argentine toad	NA	48 h	2.55 mg/L	LC_{50}	AQUIRE
	Bufo arenarum; Argentine toad	NA	48 h	3.15 mg/L	LC_{50}	AQUIRE
	Bufo arenarum; Argentine toad	NA	48 h	3.4 mg/L	LC_{50}	AQUIRE
	Bufo arenarum; Argentine toad	NA	48 h	8.6 mg/L	LC_{50}	AQUIRE
	Bufo arenarum; Argentine toad	NA	72 h	2.32 mg/L	LC_{50}	AQUIRE
	Bufo arenarum; Argentine toad	NA	72 h	2.87 mg/L	LC_{50}	AQUIRE
Cadmium Chloride (cont.)	Bufo arenarum; Argentine toad	NA	72 h	3.11 mg/L	LC_{50}	AQUIRE
	Bufo arenarum; Argentine toad	NA	72 h	7.84 mg/L	LC_{50}	AQUIRE
	Bufo arenarum; Argentine toad	NA	96 h	2.19 mg/L	LC_{50}	AQUIRE
	Bufo arenarum; Argentine toad	NA	96 h	2.65 mg/L	LC_{50}	AQUIRE
	Bufo arenarum; Argentine toad	NA	96 h	3.06 mg/L	LC_{50}	AQUIRE
	Bufo arenarum; Argentine toad	NA	96 h	6.77 mg/L	LC_{50}	AQUIRE
	Rana pipiens; Northern leopard frog	NA	1-2 d	0.307 mg/L	Mortality	AQUIRE
	Rana pipiens; Northern leopard frog	NA	1 d	0.307 mg/L	Mortality	AQUIRE
	Rana pipiens; Northern leopard frog	NA	1 d	3.068 mg/L	Mortality	AQUIRE
	Rana pipiens; Northern leopard frog	NA	1 d	4.602 mg/L	Mortality	AQUIRE
	Rana pipiens; Northern leopard frog	NA	1 d	6.135 mg/L	Mortality	AQUIRE
Cadmium Nitrate	Ambystoma mexicanum; Axolotl	3-4 weeks	48 h	1.3 mg/L	LC_{50}	Devillers & Exbrayat, 1992
	Ambystoma mexicanum; Axolotl	3-4 weeks	48 h	1.10 mg/L	NOLC	Devillers & Exbrayat, 1992
	Ambystoma mexicanum; Axolotl	NA	48 h	0.62 mg/L	LC_{50}	AQUIRE
	Xenopus laevis; Clawed toad	3-4 weeks	48 h	32 mg/L	LC_{50}	Devillers & Exbrayat, 1992
	Xenopus laevis; Clawed toad	3-4 weeks	48 h	20.2 mg/L	LC_{50}	Devillers & Exbrayat, 1992
	Xenopus laevis; Clawed toad	3-4 weeks	48 h	23 mg/L	NOLC	Devillers & Exbrayat, 1992
Chromium	Gastrophryne carolinensis; Narrow-mouthed toad	Embryo	96 h	0.03 mg/L	LC_{50}	Birge et al., 1979
Cobalt	Gastrophryne carolinensis; Narrow-					

TABLE 30
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STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

Chemical Name	Species Identification (Organism)	Age/Life Stage	Exposure Regimen	Effects Concentration	Effect	Source
	mouthed toad	Embryo	96 h	0.05 mg/L	LC_{50}	Birge et al., 1979
Copper	Gastrophryne carolinensis; Narrow-mouthed toad	Embryo	96 h	0.04 mg/L	LC_{50}	Birge et al., 1979
Copper Sulfate	Xenopus laevis; Clawed toad	3-4 weeks	48 h	1.7 mg/L	LC_{50}	Devillers & Exbrayat, 1992
Lead	Bufo americanus; American toad	Tadpole	6 d	0.5 - 1.0 mg/L	Mortality	AQUIRE
	Bufo americanus; American toad	Embryo	48 h	0.47 - 0.90 mg/L Pb^{2+}	LC_{50}	ECOTOX
	Bufo arenarum; Argentine toad	NA	24 h	1.0 mg/L	Emergence	AQUIRE
	Bufo arenarum; Argentine toad	NA	24 h	1.0 mg/L	Mortality	AQUIRE
	Gastrophryne carolinensis; Narrow-mouthed toad	Embryo	96 h	0.04 mg/L	LC_{50}	Birge et al., 1979
Lead Chloride	Ambystoma opacum; Marbled salamander	NA	8 d	1.46 mg/L	LC_{50}	AQUIRE
Lead Nitrate	Bufo arenarum; Argentine toad	Embryo	48 h	0.47-0.9 mg/L Pb^{2+}	LC_{50}	Devillers & Exbrayat, 1992
	Rana catesbeiana; Bullfrog	NA	6 d	0.5 - 1.0 mg/L	Locomotor behavior	AQUIRE
	Rana clamitans; Green frog	NA	1-6 d	0.75 mg/L	Behavior	AQUIRE
Magnesium [f]						
Manganese	Gastrophryne carolinensis; Narrow-mouthed toad	Embryo	96 h	1.42 mg/L	LC_{50}	Birge et al., 1979
Mercury	Bufo fowleri; Fowler's toad	Embryo/Larva	96 h [b]	0.0659 mg/L	LC_{50}	Devillers & Exbrayat, 1992
	Bufo punctatus; Red spotted toad	Embryo/Larva	96 h [b]	0.0368 mg/L	LC_{50}	Devillers & Exbrayat, 1992
	Gastrophryne carolinensis; Eastern narrow-mout	Embryo/Larva	96 h [b]	0.0013 mg/L	LC_{50}	Devillers & Exbrayat, 1992
	Hyla chrysoscelis; Gray treefrog	Embryo/Larva	96 h [b]	0.0024 mg/L	LC_{50}	Devillers & Exbrayat, 1992
	Rana grylio; Pig frog	Embryo/Larva	96 h [b]	0.0672 mg/L	LC_{50}	Devillers & Exbrayat, 1992
	Rana pipiens; Northern leopard frog	Embryo/Larva	96 h [b]	0.0073 mg/L	LC_{50}	Devillers & Exbrayat, 1992
Mercury chloride	Ambystoma mexicanum; Axolotl	3-4 weeks	48 h	0.4 mg/L	LC_{50}	ECOTOX
	Ambystoma mexicanum; Axolotl	3-4 weeks	48 h	0.27 mg/L	NOLC	ECOTOX
Nickel	Gastrophryne carolinensis; Narrow-mouthed toad	Embryo	96 h	0.05 mg/L	LC_{50}	Birge et al., 1979
Silver nitrate	Ambystoma opacum; Marbled salamander	NA	8 d	0.24 mg/L	LC_{50}	AQUIRE
Zinc	Gastrophryne carolinensis; Narrow-mouthed toad	Embryo	96 h	0.01 mg/L	LC_{50}	Birge et al., 1979
	Xenopus laevis; Clawed toad	Embryo	96 h	34.5 mg/L Zn	LC_{50}	Devillers & Exbrayat, 1992
Zinc Chloride	Ambystoma opacum; Marbled salamander	NA	8 d	2.38 mg/L	LC_{50}	AQUIRE

TABLE 30
SUMMARY OF TOXICITY DATA FOR AMPHIBIAN RECEPTORS

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

Chemical Name	Species Identification (Organism)	Age/Life Stage	Exposure Regimen	Effects Concentration	Effect	Source

NOTES:
LC_{50} = The concentration at which 50% of the population died (exhibited a lethal endpoint).
LD_{50} = The administered dose which causes 50% of the population to die.
EC_{50} = The concentration at which 50% of the population exhibited an effect.
TL_{50} = Mortality endpoint; concentration represents the median tolerance limit.
NOLC = No Observed Lethal Concentration

[a] RTVs calculated using the QSAR are presented in Table 31.
[b] Initiated at fertilization and maintained through 4 day posthatching.
[c] 30 minutes exposure to the sun
[d] 5 hours exposure to the sun
[e] Animals were exposed to the pesticide for 96 hours, but tabulations of mortality were made at 192 hours to account for delayed effects.
[f] Devillers & Exbrayat (1992) provides synergism data for magnesium and mercury, lead, cadmium, and manganese as % mortality.

TABLE 31
AMPHIBIAN TOXICITY VALUES GENERATED USING A QUANTITATIVE STRUCTURE-ACTIVITY RELATIONSHIP (QSAR)

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

Compound	logKow[a]	QSAR[b] [1/moles per liter]	Molecular Weight [a]	RTV mg/l
VOCs (mg/l)				
2,4,4-Trimethyl-1-pentene	NA	NC	NA	
2,4,4-Trimethyl-2-Pentene	NA	NC	NA	
Acetone	-0.24	0.50884	58	1.8E+04
Benzene	2.1	2.6359	78	1.8E+02
Bromoform	2 [c]	2.545	253	7.2E+02
Carbon Tetrachloride	2.8	3.2722	150	8.0E+01
Chlorobenzene	2.8	3.2722	110	5.9E+01
Chloroform	2	2.545	120	3.4E+02
Dichloromethane	1.3	1.9087	84	1.0E+03
Toluene	2.7	3.1813	92	6.1E+01
Trichlorothylene	2.4	2.9086	130	1.6E+02
Xylene	3.2	3.6358	110	2.5E+01
SVOCs (mg/l)				
1,2-Dibromomethane	2	2.545	190	5.4E+02
2-Proponone	-0.24	0.50884	58	1.8E+04
4-Chloroaniline	1.8	2.3632	130	5.6E+02
Anthracene	4.5	4.8175	180	2.7E+00
Benzo(a)pyrene	6	6.181	250	1.6E-01
bis(2-EthylHexyl)phthalate	5.1	5.3629	390	1.7E+00
Di-n-octylphthalate	9.2	9.0898	390	3.2E-04
Fluoranthene	4.95 [d]	5.22655	200	1.2E+00
Naphthalene	3.6	3.9994	130	1.3E+01
Nitrobenzene	1.9	2.4541	120	4.2E+02
N-Nitrosodiphenylamine (1)	3.1	3.5449	200	5.7E+01
Pentachlorophenol	5.9	6.0901	270	2.2E-01
Phenol	1.5	2.0905	94	7.6E+02
Pyrene	5.3	5.5447	200	5.7E-01

[a] Logkow and molecular weights were selected from the Superfund Chemical Data Matrix (SCDM, 1993), unless otherwise noted.
[b] The QSAR (log[1/C] = 0.909[logP] + 0.727) used to develop these RTVs is presented in Lipnick, R.L. (1989).
[c] LogKow for chloroform used as a surrogate.
[d] USEPA (1992), Dermal Exposure Guidance.

TABLE 32
SUMMARY OF SURVIVAL DATA FOR EARTHWORM *(Eisenia foetida)*

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

Sample Location/ Sample Number	Number Organisms Alive (*Eisenia foetida*)				Mean Survival	Significant Difference From	
						Lab	Reference
Laboratory Control	10	10	10	10	100.0%		NO
BS021REFX (-9)	10	10	10	10	100.0%	NO	
BS013WDXX (-1)	10	10	10	10	100.0%	NO	NO
BS014WDXX (-2)	10	10	10	10	100.0%	NO	NO
BS015SDXX (-3)	10	10	10	10	100.0%	NO	NO
BS016SMDX (-4)	10	9	10	10	97.5%	NO	NO
BS017PNDX (-5)	10	10	10	10	100.0%	NO	NO
BS018PNDX (-6)	10	10	10	10	100.0%	NO	NO
BS019WMDX (-7)	10	10	10	10	100.0%	NO	NO
BS020WMDX (-8)	9	10	10	10	97.5%	NO	NO

Olin Chemical Company Site Soil Toxicity Evaluation, January 1997.
ESI Study Number 6244.

From: ESI, 1997

TABLE 33
SUMMARY OF WEIGHT DATA FOR EARTHWORM *(Eisenia foetida)*

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

Sample Location/ Sample Number	Wet Weight of Surviving Individual Organisms (g) (*Eisenia foetida*)				Mean Weight (Grams)	Significant Difference From	
						Lab	Reference
Laboratory Control	0.380	0.329	0.358	0.355	0.355		NO
BS021REFX (-9)	0.375	0.398	0.349	0.384	0.376	NO	
BS013WDXX (-1)	0.374	0.366	0.377	0.341	0.367	NO	NO
BS014WDXX (-2)	0.390	0.365	0.349	0.380	0.371	NO	NO
BS015SDXX (-3)	0.361	0.366	0.380	0.321	0.357	NO	NO
BS016SMDX (-4)	0.298	0.297	0.313	0.310	0.304	YES	YES
BS017PNDX (-5)	0.397	0.364	0.359	0.328	0.362	NO	NO
BS018PNDX (-6)	0.337	0.334	0.338	0.354	0.341	NO	NO
BS019WMDX (-7)	0.362	0.361	0.410	0.385	0.380	NO	NO
BS020WMDX (-8)	0.348	0.313	0.313	0.323	0.324	NO	YES

Olin Chemical Company Site Soil Toxicity Evaluation, January 1997.
ESI Study Number 6244.

From: ESI, 1997.

TABLE 34
SUMMARY OF COCOON PRODUCTION DATA FOR EARTHWORM *(Eisenia foetida)*

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

Sample Location/ Sample Number	Number Cocoons Produced (*Eisenia foetida*)				Mean Number Cocoons	Significant Difference From	
						Lab	Reference
Laboratory Control	19	21	25	26	22.8		YES
BS021REFX (-9)	0	0	1	0	0.3	YES	
BS013WDXX (-1)	1	3	0	2	1.5	YES	NO
BS014WDXX (-2)	1	1	0	1	0.8	YES	NO
BS015SDXX (-3)	0	0	1	0	0.3	YES	NO
BS016SMDX (-4)	0	0	0	0	0.0	YES	NO
BS017PNDX (-5)	0	0	1	0	0.3	YES	NO
BS018PNDX (-6)	0	0	0	1	0.3	YES	NO
BS019WMDX (-7)	1	0	0	0	0.3	YES	NO
BS020WMDX (-8)	0	1	0	0	0.3	YES	NO

Olin Chemical Company Site Soil Toxicity Evaluation, January 1997.
ESI Study Number 6244.

From: ESI, 1997.

TABLE 35
SUMMARY OF TOXICITY DATA FOR TERRESTRIAL INVERTEBRATE RECEPTORS

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

CHEMICAL	TEST TYPE	TEST DURATIO	TEST SPECIES	CHEMICAL CONCENTRATION (mg/kg)	EFFECT	RTV (mg/kg)		REFERENCE
VOLATILE ORGANIC COMPOUNDS								
1,1,1-Trichloroethane	Soil Test	14 day	E. fetida	740	LC_{50}	150	[a]	Neuhauser et al., 1985.
1,1,2,2-Tetrachloroehane	Soil Test	14 day	E. fetida	740	LC_{50}	150	[a]	Neuhauser et al., 1985.
1,2-Dichloroethane	Soil Test	14 day	E. fetida	740	LC_{50}	150	[a]	Neuhauser et al., 1985.
1,2-Dichloroethene (total)	Soil Test	14 day	E. fetida	740	LC_{50}	150	[a]	Neuhauser et al., 1985.
2-Butanone	NA	NA	NA	NA	NA	NA		NA
Acetone	NA	NA	NA	NA	NA	NA		NA
Benzene	Soil Test	14 day	E. fetida	106	LC_{50}	20	[a]	Neuhauser et al., 1985.
Carbon tetrachloride	Soil Test	14 day	E. fetida	740	LC_{50}	150	[a]	Neuhauser et al., 1985.
Chlorobenzene	Soil Test	14 day	E. fetida	106	LC_{50}	20	[a]	Neuhauser et al., 1985.
Ethylbenzene	Soil Test	14 day	E. fetida	106	LC_{50}	20	[a]	Neuhauser et al., 1985.
Methylene chloride	Soil Test	14 day	E. fetida	740	LC_{50}	150	[a]	Neuhauser et al., 1985.
Tetrachloroethene	Soil Test	14 day	E. fetida	740	LC_{50}	150	[a]	Neuhauser et al., 1985.
Toluene	Soil Test	14 day	E. fetida	106	LC_{50}	20	[a]	Neuhauser et al., 1985.
Trichloroethylene	Soil Test	14 day	E. fetida	740	LC_{50}	150	[a]	Neuhauser et al., 1985.
Xylene (total)	Soil Test	14 day	E. fetida	106	LC_{50}	20	[a]	Neuhauser et al., 1985.
Vinyl chloride	Soil Test	14 day	E. fetida	740	LC_{50}	150	[a]	Neuhauser et al., 1985.
SEMI-VOLATILE ORGANIC COMPOUNDS								
2-Methylnaphthalene	Soil Test	14 day	E. fetida	173	LC_{50}	34	[a]	Neuhauser et al., 1985.
2,4-Dimethylphenol	Soil Test	14 day	E. fetida	38	LC_{50}	8	[a]	Neuhauser et al., 1985.
2,6-Dinitrotoluene	Soil Test	14 day	E. fetida	38	LC_{50}	8	[a]	Neuhauser et al., 1985.
4-Chloroanaline	Soil Test	14 day	E. fetida	38	LC_{50}	8	[a]	Neuhauser et al., 1985.
4-Methylphenol	Soil Test	14 day	E. fetida	38	LC_{50}	8	[a]	Neuhauser et al., 1985.
4-Nitrophenol	Soil Test	14 day	E. fetida	38	LC_{50}	8	[a]	Neuhauser et al., 1985.
Acenaphthene	Soil Test	14 day	E. fetida	173	LC_{50}	34	[a]	Neuhauser et al., 1985.
Acenaphthylene	Soil Test	14 day	E. fetida	173	LC_{50}	34	[a]	Neuhauser et al., 1985.
Anthracene	Soil Test	14 day	E. fetida	173	LC_{50}	34	[a]	Neuhauser et al., 1985.
Benzo(a)anthracene	Soil Test	14 day	E. fetida	173	LC_{50}	34	[a]	Neuhauser et al., 1985.
Benzo(a)pyrene	Soil Test	14 day	E. fetida	173	LC_{50}	34	[a]	Neuhauser et al., 1985.
Benzo(b and k)fluoranthene	Soil Test	14 day	E. fetida	173	LC_{50}	34	[a]	Neuhauser et al., 1985.
Benzo(g,h,i)perylene	Soil Test	14 day	E. fetida	173	LC_{50}	34	[a]	Neuhauser et al., 1985.
Benzoic acid	NA	NA	NA	NA	NA	NA		NA
Bis(2-ethylhexyl)phthalate	Soil Test	14 day	E. fetida	3160	LC_{50}	630	[a]	Neuhauser et al., 1985.
Butylbenzylphthalate	Soil Test	14 day	E. fetida	3160	LC_{50}	630	[a]	Neuhauser et al., 1985.
Carbazole	Soil Test	14 day	E. fetida	173	LC_{50}	34	[a]	Neuhauser et al., 1985.
Chrysene	Soil Test	14 day	E. fetida	173	LC_{50}	34	[a]	Neuhauser et al., 1985.
Dibenz(a,h)anthracene	Soil Test	14 day	E. fetida	173	LC_{50}	34	[a]	Neuhauser et al., 1985.
Dibenzofuran	NA	NA	NA	NA	NA	NA		NA
Diethylphthalate	Soil Test	14 day	E. fetida	3160	LC_{50}	630	[a]	Neuhauser et al., 1985.
di-n-Butylphthalate	Soil Test	14 day	E. fetida	3160	LC_{50}	630	[a]	Neuhauser et al., 1985.
di-n-Octylphthalate	Soil Test	14 day	E. fetida	3160	LC_{50}	630	[a]	Neuhauser et al., 1985.

TABLE 35
SUMMARY OF TOXICITY DATA FOR TERRESTRIAL INVERTEBRATE RECEPTORS

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

CHEMICAL	TEST TYPE	TEST DURATIO	TEST SPECIES	CHEMICAL CONCENTRATION (mg/kg)	EFFECT	RTV (mg/kg)		REFERENCE
Fluoranthene	Soil Test	14 day	E. fetida	173	LC_{50}	34	[a]	Neuhauser et al., 1985.
Fluorene	Soil Test	14 day	E. fetida	173	LC_{50}	34	[a]	Neuhauser et al., 1985.
Indeno(1,2,3-c,d)pyrene	Soil Test	14 day	E. fetida	173	LC_{50}	34	[a]	Neuhauser et al., 1985.
Isophorone	Soil Test	14 day	E. fetida	173	LC_{50}	34	[a]	Neuhauser et al., 1985.
Naphthalene	Soil Test	14 day	E. fetida	173	LC_{50}	34	[a]	Neuhauser et al., 1985.
Nitrobenzene	Soil Test	14 day	E. fetida	106	LC_{50}	20	[a]	Neuhauser et al., 1985.
N-Nitrosodiphenylamine	Soil Test	14 day	E. fetida	151	LC_{50}	6	[a]	Neuhauser et al., 1985.
Pentachlorophenol	Soil Test	14 day	E. fetida	38	LC_{50}	8	[a]	Neuhauser et al., 1985.
Phenanthrene	Soil Test	14 day	E. fetida	173	LC_{50}	34	[a]	Neuhauser et al., 1985.
Phenol	Soil Test	14 day	E. fetida	38	LC_{50}	8	[a]	Neuhauser et al., 1985.
Pyrene	Soil Test	14 day	E. fetida	173	LC_{50}	34	[a]	Neuhauser et al., 1985.
PESTICIDES					LC_{50}			
Aldrin	Soil Test	24 hour	P. posthuma	103	LC_{50}			Hans et al., 1990
Aldrin	Soil Test	7 day	P. posthuma	22	LC_{50}			Hans et al., 1990
Aldrin	Soil Test	14 day	P. posthuma	11	LC_{50}	2.2	[b]	Hans et al., 1990
Aroclor-1242	NA	NA	NA	NA	NA	NA		NA
Aroclor-1254	NA	NA	NA	NA	NA	NA		NA
Aroclor-1260	NA	NA	NA	NA	NA	NA		NA
alpha-BHC	Soil Test		P. posthuma		LC_{50}	8	[c]	Hans et al., 1990
beta-BHC	Soil Test		P. posthuma		LC_{50}	8	[c]	Hans et al., 1990
delta-BHC	Soil Test		P. posthuma		LC_{50}	8	[c]	Hans et al., 1990
gamma-BHC (lindane)	Soil Test	24 hour	P. posthuma	78	LC_{50}			Hans et al., 1990
gamma-BHC (lindane)	Soil Test	7 day	P. posthuma	55	LC_{50}			Hans et al., 1990
gamma-BHC (lindane)	Soil Test	14 day	P. posthuma	40	LC_{50}	8	[b]	Hans et al., 1990
alpha-Chlordane	NA	NA	NA	NA	NA	NA		NA
gamma-Chlordane	NA	NA	NA	NA	NA	NA		NA
Dieldrin	Soil Test	89 day	E. fetida	10	6 % decrease in number of cocoons hatched			Reinecke and Venter, 1985
Dieldrin	Soil Test	89 day	E. fetida	30	26 % decrease in number of cocoons hatched	30		Reinecke and Venter, 1985
Dieldrin	Soil Test	89 day	E. fetida	100	36 % decrease in number of cocoons hatched;			Reinecke and Venter, 1985
Dieldrin	Soil Test	89 day	E. fetida		50 % decrease in number of cocoons produced			Reinecke and Venter, 1985
4,4'-DDD	Soil Test	NS	NS	60	58% mortality	12	[b]	U.S. EPA, 1985
4,4'-DDE	Soil Test	NS	NS	60	58% mortality	12	[b]	U.S. EPA, 1985
4,4'-DDT	Soil Test	NS	NS	60	58% mortality	12	[b]	U.S. EPA, 1985
Endosulfan I	Soil Test	24 hour	P. posthuma	5	LC_{50}	1	[b]	Hans et al., 1990
Endosulfan II	Soil Test	24 hour	P. posthuma	5	LC_{50}	1	[b,d]	Hans et al., 1990
Endosulfan sulfate	Soil Test	24 hour	P. posthuma	5	LC_{50}	1	[b]	Hans et al., 1990
Endrin	NA	NA	NA	NA	NA	NA		NA
Endrin aldehyde	NA	NA	NA	NA	NA	NA		NA
Edrin ketone	NA	NA	NA	NA	NA	NA		NA
Heptachlor	Soil Test	24 hour	P. posthuma	75	LC_{50}			Hans et al., 1990
Heptachlor	Soil Test	7 day	P. posthuma	49	LC_{50}			Hans et al., 1990
Heptachlor	Soil Test	14 day	P. posthuma	32	LC_{50}	6.4	[b]	Hans et al., 1990

TABLE 35
SUMMARY OF TOXICITY DATA FOR TERRESTRIAL INVERTEBRATE RECEPTORS

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

CHEMICAL	TEST TYPE	TEST DURATIO	TEST SPECIES	CHEMICAL CONCENTRATION (mg/kg)	EFFECT	RTV (mg/kg)	REFERENCE
Heptachlor epoxide	Soil Test		P. posthuma		LC_{50}	6.4 [e]	Hans et al., 1990
Methoxychlor	NA	NA	NA	NA	NA	NA	NA
INORGANICS							
Aluminum	NA	NA	NA	NA	NA	NA	NA
Arsenic	Soil Test	14 day	E. fetida	100	0 % mortality	100	Bouche et al., 1987
Arsenic	Soil Test	14 day	E. fetida	200	100 % mortality		Bouche et al., 1987
Barium	NA	NA	NA	NA	NA	NA	NA
Beryllium	NA	NA	NA	NA	NA	NA	NA
Cadmium	Soil Test	14 day	E. fetida	900	0 % mortality		Bouche et al., 1987
Cadmium	Soil Test	14 day	E. fetida	2700	100 % mortality		Bouche et al., 1987
Cadmium	Soil Test	14 day	E. fetida	1000 [f]	LC_{50}		VanGestel and VanDis, 1988
Cadmium	Soil Test	20 week	E. fetida	50 [g]	Decrease in cocoon production	50 [b]	Malecki et al., 1982
Cadmium	Soil Test	2 week	E. fetida	1843	LC_{50}		Neuhauser et al., 1985
Chromium (III)	Soil Test	8 week	E. fetida	250	Reproduction 50% inhibited	50	Molnar et al., 1989
Cobalt	NA	NA	NA	NA	NA	NA	NA
Copper	Soil Test	14 day	E. fetida	10	0 % mortality		Bouche et al., 1987
Copper	Soil Test	14 day	E. fetida	30	20 % mortality	30	Bouche et al., 1987
Copper	Soil Test	20 week	E. fetida	1000 [g]	Decrease in cocoon production		Malecki et al., 1982
Copper	Soil Test	2 week	E. fetida	643	LC_{50}		Neuhauser et al., 1985
Cyanide	NA	NA	NA	NA	NA	NA	NA
Lead	Soil Test	20 week	E. fetida	5000 [g]	Decrease in cocoon production		Malecki et al., 1982
Lead	Soil Test	2 week	E. fetida	5941	LC_{50}	1190 [b]	Neuhauser et al., 1985
Manganese	NA	NA	NA	NA	NA	NA	NA
Mercury	Soil Test	14 day	E. fetida	36	0 % mortality	36	Bouche et al., 1987
Mercury	Soil Test	14 day	E. fetida	216	60 % mortality		Bouche et al., 1987
Nickel	Soil Test	20 week	E. fetida	400 [g]	Decrease in cocoon production	400	Malecki et al., 1982
Nickel	Soil Test	2 week	E. fetida	757	LC_{50}		Neuhauser et al., 1985
Selenium	NA	NA	NA	NA	NA	NA	NA
Silver	NA	NA	NA	NA	NA	NA	NA
Vanadium	NA	NA	NA	NA	NA	NA	NA
Zinc	Soil Test	20 week	E. fetida	5000 [g]	Decrease in cocoon production		Malecki et al., 1982
Zinc	Soil Test	2 week	E. fetida	662	LC_{50}	130 [b]	Neuhauser et al., 1985

NOTES:
[a] Equal to the lowest LC_{50} in each chemical class, multiplied by a safety factor of 0.2.
[b] Conservative factor of 0.2 applied to endpoint; resultant value should be protective of 99.9% of the exposed population from acute effects (USEPA, 1986a).
[c] Value for gamma-BHC used as a surrogate
[d] Value for Endosulfan I used as a surrogate
[e] Value for heptachlor used as a surrogate
[f] LC_{50} value for soil at pH = 7.0; LC_{50} = 320 ug/g - 560 ug/g for soil pH = 4.1
[g] Acetate salt
NA = Not Available
NS = not stated.

Are these Units correct?

TABLE 36
FETAX TOXICITY TEST, ELUTRIATE WATER and SEDIMENT ANALYTICAL RESULTS
(SVOCs and Metals)

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

SAMPLE LOCATIONS		BS005WDXX		BS006WDXX		BS007WDO		BS008SDX		BS009PND		BS010PND		BS011WMD		BS012REF	
FETAX RESULTS																	
Mean Percent Survival		52%		34%		68%		78%		60%		78%		76%		80%	
Mean Percent Normal		10%		0%		38%		56%		36%		44%		66%		58%	
Statistically significant from:																	
Control, Surv./Devel.		Yes/Yes		Yes/Yes		No/Yes		No/No		Yes/Yes		No/Yes		No/No		No/No	
Reference, Surv./Devel.		Yes/Yes		Yes/Yes		No/No		No/No		No/No		No/No		No/No		NA/NA	
ANALTICAL RESULTS SVOCs (mg/L, mg/kg)	**AQUATIC RTV [a]**	Elut.	Sed.	Elut.	Sed.	Elut.	Sed.	Elut.	Sed.	Elut.	Sed.	Elut.	Sed.	Elut.	Sed.	Elut.	Sed.
N-Nitrosodiphenylamine	57	0.012	550 U	1.3	46 J	0.01 U	0.42 U	0.77	270 J	0.01 U	0.42 U	0.048	54 J	0.01 U	0.61 U	0.01 U	1.3 U
Di-n-butylphthalate	0.0032 ~~32000~~ [b]	7E-04 J	550 U	1 U	1200 U	0.01 U	0.42 U	0.2 U	800 U	0.01 U	0.42 U	0.001 J	43 J	0.01 U	0.02 J	0.01 U	1.3 U
Fluoranthene	0.09	3E-04 J	550 U	1 U	1200 U	0.01 U	0.72	0.2 U	800 U	0.01 U	0.42 U	0.01 U	1100 U	0.01 U	0.61 U	0.01 U	1.2 J
bis(2-Ethylhexyl)phthalat	3.88	0.45 E	3600 B	33 E	5600 U	0.01 U	0.46 B	11 E	6500 B	0.007 J	2.4 B	0.25 E	6400 B	0.005 J	0.26 JB	0.002 J	1 JB
Di-n-octylphthalate	0.0032 ~~32000~~	0.003 J	550 U	0.2 J	1200 U	0.01 U	0.42 U	0.051 J	800 U	0.01 U	0.42 U	0.005 J	1100 U	0.01 U	0.61 U	0.01 U	1.3 U
ANALYTICAL RESULTS Metals (mg/L, mg/kg)																	
Aluminum	0.403	49	4500	0.78	6500	1	4000	5	4200	0.39	4900	2	67000	2	8700	220	20400
Antimony	NA	0.014 B	1.9 B	0.0068 B	1.1 B	0.004 U	0.98 U	0.011 B	6.3 B	0.004 U	1.3 B	0.004 U	52	0.004 U	2 B	0.004 U	2.8 U
Arsenic	0.19 [c]	0.096	4.3	0.006 U	6.4	0.006 U	1.9 B	0.006 U	6.2	0.006 U	5.5	0.006 U	26	0.006 U	5.8	0.25	27
Barium	NA	0.46	42 B	0.048 B	13 B	0.020 B	5.4 B	0.024 B	14 B	0.017 B	8.5 B	0.021 B	36 B	0.040 B	29 B	0.99	106 B
Beryllium	3.2	0.0019 B	0.3 U	0.001 U	0.28 B	0.001 U	0.30 B	0.001 U	0.38 B	0.001 U	0.22 B	0.001 U	10.4	0.001 U	0.41 B	0.0084	0.71 U
Cadmium	0.307	0.029	1.3 B	0.001 U	0.40 B	0.001 U	0.24 U	0.001 U	0.24 U	0.001 U	0.21 U	0.001 U	2.7 B	0.001 U	0.36 U	0.012	0.71 U
Calcium	NA [d]	29	1400 B	460	7600	17	340 B	6.1	450 B	32	508 B	70	4700	32	1100 B	31	2300 B
Chromium	0.03	1.7	130	0.033	240	0.022	103	2.4	1600	0.051	470	0.37	14000	0.013	34	0.22	24
Cobalt	0.05	0.0056 B	1.7 B	0.001 U	3 B	0.001 U	1.6 B	0.0012 B	1.9 B	0.001 U	1.8 B	0.017 B	38	0.008 B	3.6 B	0.17	23 B
Copper	0.04	0.25	10.4	0.0041 B	16	0.0018 B	4.2 B	0.033	7.8	0.0021 B	4.6 B	0.0064 B	98	0.0012 B	2.2 B	0.54	58
Iron	1 [c]	37	4300	0.81	6600	0.14	2800	6	5900	0.13	5700	2.6	68000	0.33	3600	340	34000
Lead	0.47	0.26	14	0.0046	13	0.002 U	3.0	0.015	4.7	0.002 U	2.3	0.003	60	0.0032	9.8	1.4	150
Magnesium	NA [d]	5.7	59 B	12	809 B	7.2	560 B	2.8 B	460 B	12	1200	8.3	660 B	9.3	740 B	20	1900 B
Manganese	1.4	0.28	29	0.20	60	0.20	26	0.056	27	0.049	41	0.29	72	1.3	59	12	780
Mercury	0.0013	0.0046	0.27	0.0002 U	0.14 U	0.0002 U	0.13 U	0.0007	0.23	0.0002 U	0.086 U	0.0002 U	1	0.0002 U	0.17 U	0.0021	0.35 U
Nickel	0.05	0.007 B	9.3 B	0.001 U	8.8 B	0.001 U	4.2 B	0.001 U	4 B	0.001 U	5.2 B	0.001 U	110	0.001 U	5.8 B	0.13	21 B
Potassium	NA [d]	13 E	170 BE	13 E	230 BE	13 E	180 BE	14 E	130 BE	18 E	230 BE	16 E	330 BE	10 E	200 BE	22 E	480 BE
Selenium	NA	0.004 U	1.2 U	0.004 U	0.94 U	0.004 U	0.96 U	0.004 U	0.98 U	0.004 U	0.83 U	0.004 U	2.9 U	0.004 U	1.4 U	0.013	2.8 U
Sodium	NA [d]	120 E	340 BE	130 E	230 BE	120 E	87 BE	130 E	290 BE	140 E	108 BE	130 E	460 BE	130 E	280 BE	130 E	330 BE
Thallium	NA	0.007 U	2.1 U	0.007 U	1.6 U	0.007 U	1.7 U	0.007 U	1.7 U	0.007 U	1.5 U	0.007 U	5 U	0.007 U	2.5 U	0.019	4.9 U
Vanadium	NA	0.19	19	0.0026 B	14	0.001 U	4.5 B	0.011 B	9.1 B	0.001 U	9.9 B	0.0013 B	50.3	0.0018 B	7.6 B	0.26	31 B
Zinc	0.01	2.4	110 E	0.024	101 E	0.022	11 E	0.044	23 E	0.014 B	12 E	0.030	370 E	0.018 B	11 E	2.9	380 E

Notes:
[a] Aquatic RTVs for surface water are presented in Table 27 (Summary of Toxicity Data for Amphibian Receptors).
[b] Value for Di-n-octylphthalate used as surrogate.
[c] Amphibian toxicity data not available for this OHMPC. Value shown is chronic freshwater AWQC (USEPA, 1986b).
[d] Essential nutrients

Shading indicates exceedance of the aquatic RTV.

TABLE 37
SUMMARY OF R^2 VALUES FOR REGRESSION OF SURVIVAL VERSES ELUTRIATE WATER CONCENTRATION

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

OHMPC	R^2
bis(2-Ethylhexyl)phthalate	0.457
N-Nitrosodiphenylamine	0.278
Aluminum	0.0727
Antimony	0.0915
Arsenic	0.0993
Barium	0.119
Beryllium	0.0993
Cadmium	0.0993
Chromium	0.0344
Cobalt	0.211
Copper	0.0749
Iron	0.062
Lead	0.093
Manganese	0.084
Mercury	0.0716
Nickel	0.0993
Selenium	NA
Thallium	NA
Vanadium	0.0916
Zinc	0.0972

NA = Regression analysis was not conducted for these analytes, as they were not detected in elutriate water.

TABLE 38
FETAX SCREENING ASSAY RESULTS RELATIVE TO POPULATION MODEL RESULTS

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

Location	Screening Assay Results		Population Model Results			
			If Toxicity Occurs Before Density Dependence		If Toxicity Occurs After Density Dependence	
	% Survival	% Normal Development [a]	> 25% Reduction	> 50% Reduction	> 25% Reduction	> 50% Reduction
BS005WDX b	52 *	10 *	No	No	Yes	Yes
BS006WDX b	34 *	0 *	Yes	Yes	Yes	Yes
BS007WDO a	68	38	No	No	Yes	No
BS008SDX c	78	56	No	No	Yes	No
BS009PND d	60	36	No	No	Yes	No
BS010PND d	78	44	No	No	Yes	No
BS011WMD	76	66	No	No	Yes	No
BS012REF	80	58	No	No	Yes	No

Notes:
* = Significantly different from reference site.
[a] According to FETAX protocol, % normal development is calculated as follows:
% normal = (total # test organisms - # dead organisms - # malformed)/ total # test organisms*100
Therefore, assuming that malformed organisms do not live to maturity, % normal development is actually a more accurate representation of survival.

a = West ditch off
b = West ditch on
c = South ditch
d = POND

TABLE 39
FETAX DEFINITIVE ASSAY RESULTS RELATIVE TO POPULATION MODEL RESULTS

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

		Definitive Assay Results		Population Model Results			
				If Toxicity Occurs Before Density Dependence		If Toxicity Occurs After Density Dependence	
Location	% Elutriate	% Survival	% Normal Development [a]	> 25 % Reduction	> 50% Reduction	> 25 % Reduction	> 50% Reduction
BS005WDX							
	100	76.7	40	No	No	Yes	No
	50	70	23.3	No	No	Yes	Yes
	25	73.3	33.3	No	No	Yes	No
	12.5	70	36.7	No	No	Yes	No
	6.25	60	46.7	No	No	Yes	No
BS006WDX							
	100	53.3	10	No	No	Yes	Yes
	50	56.7	30	No	No	Yes	No
	25	63.3	26.7	No	No	Yes	Yes
	12.5	56.7	26.7	No	No	Yes	Yes
	6.25	93.3	66.7	No	No	Yes	No
BS009PND							
	100	33.3	20	No	No	Yes	Yes
	50	53.3	20	No	No	Yes	Yes
	25	93.3	63.3	No	No	Yes	No
	12.5	66.7	46.7	No	No	Yes	No
	6.25	83.3	46.7	No	No	Yes	No

Notes:
[a] According to FETAX protocol, % normal development is calculated as follows:
% normal = (total # test organisms - # dead organisms - # malformed)/ total # test organisms*100
Therefore, assuming that malformed organisms do not live to maturity, % normal development is actually a more accurate representation of survival.

TABLE 40
COMPARISON OF SURFACE WATER OHMPC CONCENTRATIONS WITH AQUATIC RTVs [a]
OFF-PROPERTY WEST DITCH (UNFILTERED, HISTORICAL) - AQUATIC DITCH HABITAT

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

ANALYTE	EXPOSURE POINT CONCENTRATION [b]	FREQUENCY OF DETECTION	BKGD MAX	AQUATIC RTV [c]		HAZARD QUOTIENT
SURFACE WATER						
VOCs (mg/L)						
2,4,4-Trimethyl-1-pentene	0.049	3 / 5	NB	NA		NC
2,4,4-Trimethyl-2-pentene	0.021	3 / 5	NB	NA		NC
Acetone	0.016	1 / 5	NB	12000		1.3E-06
Bromoform	0.0023	3 / 5	NB	720		3.2E-06
SVOCs (mg/L)						
Di-n-octylphthalate	0.0010 *	1 / 5	NB	0.00032		3.1E+00
N-Nitrosodiphenylamine (1)	0.0095	3 / 5	NB	57		1.7E-04
Phenol	0.0031	4 / 5	NB	0.27		1.1E-02
bis(2-EthylHexyl)phthalate	0.006 *	1 / 5	NB	3.88		1.5E-03
Pesticides/PCBs (mg/L)						
Heptachlor Epoxide	0.0001	1 / 5	ND	0.44		2.3E-04
Metals (mg/L)						
Aluminum	11	4 / 5	0.37	0.403		2.7E+01
Barium	0.027	5 / 5	0.034	NA		NC
Chromium	2.7	4 / 5	ND	0.03		8.9E+01
Cobalt	0.037	3 / 5	ND	0.05		7.3E-01
Copper	0.034	1 / 5	ND	0.04		8.5E-01
Hexavalent Chromium	0.20	1 / 1	ND	0.03	[d]	6.7E+00
Iron	7.8	5 / 5	1.8	1	[e]	7.8E+00
Lead	0.0050	1 / 5	ND	0.47		1.1E-02
Manganese	1.7	5 / 5	0.1	1.42		1.2E+00
Nickel	0.044	2 / 5	ND	0.05		8.8E-01
Zinc	0.083	3 / 5	0.048	0.01		8.3E+00
Inorganics (mg/L)						
Chloride	130	5 / 5	110	230	[e]	5.7E-01
Nitrate as N	0.70	2 / 2	NA	NA		NC
Nitrogen, Ammonia	63	5 / 5	NA	2.2	[e]	2.9E+01
Sulfate as SO4	430	5 / 5	24	NA		NC
			HAZARD INDEX			1.7E+02

NOTES:

[a] OHMPC selection presented in Table 3.

[b] Exposure point concentration is the arithmetic mean of all sample results with 1/2 the SQL used for nondetects. Some averages may exceed maximum concentrations due to elevated SQLs, in which case the maximum detected concentration was used as the exposure point concentration. (Identified with an "*")

[c] Aquatic RTVs for surface water are presented in Table 30.

[d] Value for chromium used as a surrogate.

[e] Amphibian toxicity data not available for this OHMPC. Value shown is chronic freshwater AWQC.

Hazard Quotient calculated by dividing the exposure point concentration by the RTV.

Hazard Index calculated by summing all HQs.

NA = Not available

NB = Not considered a background analyte

NC = Not calculated

ND = Not detected in background samples

TABLE 41
COMPARISON OF SURFACE WATER OHMPC CONCENTRATIONS WITH AQUATIC RTVs [a]
OFF-PROPERTY WEST DITCH (UNFILTERED, RECENT) - AQUATIC DITCH HABITAT

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

ANALYTE	EXPOSURE POINT CONCENTRATION [b]	FREQUENCY OF DETECTION	BKGD MAX	AQUATIC RTV [c]	HAZARD QUOTIENT
SURFACE WATER					
Metals (mg/L)					
Aluminum	0.16	2 / 3	0.37	0.403	3.9E-01
Barium	0.015	3 / 3	0.034	NA	NC
Iron	2.4	2 / 3	1.8	1 [d]	2.4E+00
Manganese	0.20	3 / 3	0.1	1.42	1.4E-01
Inorganics (mg/L)					
Chloride	63	3 / 3	110	230 [d]	2.7E-01
Nitrate as N	0.43	2 / 3	NA	NA	NC
Nitrogen, Ammonia	2.3	2 / 3	NA	3.27 ~~2.2~~ [d]	~~1.0E+00~~ 7.1E-01
Sulfate as SO4	36	3 / 3	24	NA	NC
			HAZARD INDEX		**4.3E+00**

NOTES:

[a] CPC selection presented in Table 2.

[b] Exposure point concentration is the arithmetic mean of all sample results with 1/2 the SQL used for nondetects. Some averages may exceed maximum concentrations due to elevated SQLs, in which case the maximum detected concentration was used as the exposure point concentration. (Identified with an "*")

[c] Aquatic RTVs for surface water are presented in Table 30.

[d] Amphibian toxicity data not available for this CPC. Value shown is chronic freshwater AWQC.

Hazard Quotient calculated by dividing the exposure point concentration by the RTV.

Hazard Index calculated by summing all HQs.

NA = Not available

NC = Not calculated

TABLE 42
COMPARISON OF SURFACE WATER OHMPC CONCENTRATIONS WITH AQUATIC RTVs [a]
ON-PROPERTY WEST DITCH (UNFILTERED, HISTORICAL) - AQUATIC DITCH HABITAT

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

ANALYTE	EXPOSURE POINT CONCENTRATION [b]	FREQUENCY OF DETECTION	BKGD MAX	AQUATIC RTV [c]	HAZARD QUOTIENT
SURFACE WATER					
Metals (mg/L)					
Aluminum	0.19	2 / 2	0.37	0.403	4.7E-01
Arsenic	0.0085	2 / 2	ND	0.19 [d]	4.5E-02
Barium	0.0080	2 / 2	0.034	NA	NC
Iron	0.29	2 / 2	1.8	1 [d]	2.9E-01
Manganese	0.015	2 / 2	0.1	1.42	1.1E-02
Zinc	0.019	1 / 2	0.048	0.01	1.9E+00
Inorganics (mg/L)					
Chloride	220	2 / 2	110	230 [d]	9.6E-01
Nitrate as N	6.4	1 / 1	NA	NA	NC
Nitrite as N	0.054	1 / 1	NA	NA	NC
Nitrogen, Ammonia	0.16	1 / 2	NA	2.77 2.2 [d]	7.0E-02
Sulfate as SO4	77	2 / 2	24	NA	NC
			HAZARD INDEX		3.8E+00

NOTES:

[a] OHMPC selection presented in Table 3.

[b] Exposure point concentration is the arithmetic mean of all sample results with 1/2 the SQL used for nondetects. Some averages may exceed maximum concentrations due to elevated SQLs, in which case the maximum detected concentration was used as the exposure point concentration. (Identified with an "*")

[c] Aquatic RTVs for surface water are presented in Table 30.

[d] Amphibian toxicity data not available for this CPC. Value shown is chronic freshwater AWQC.

Hazard Quotient calculated by dividing the exposure point concentration by the RTV.

Hazard Index calculated by summing all HQs.

NA = Not available

NC = Not calculated

ND = Not detected in background samples.

TABLE 43
COMPARISON OF SURFACE WATER OHMPC CONCENTRATIONS WITH AQUATIC RTVs [a]
SOUTH DITCH (UNFILTERED, HISTORICAL) - AQUATIC DITCH HABITAT

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

ANALYTE	EXPOSURE POINT CONCENTRATION [b]	FREQUENCY OF DETECTION	BKGD MAX	AQUATIC RTV [c]		HAZARD QUOTIENT
SURFACE WATER						
VOCs (mg/L)						
2,4,4-Trimethyl-1-pentene	0.0069	5 / 7	NB	NA		NC
2,4,4-Trimethyl-2-Pentene	0.0039	4 / 7	NB	NA		NC
SVOCs (mg/L)						
Di-n-octylphthalate	0.0049	2 / 7	NB	0.00032		1.5E+01 ✓
N-Nitrosodiphenylamine (1)	0.0025 *	5 / 7	NB	57		4.4E-05
Phenol	0.001 *	1 / 7	NB	0.27		3.7E-03
bis(2-EthylHexyl)phthalate	0.018	5 / 7	NB	3.88		4.6E-03
Metals (mg/L)						
Aluminum	5.04	7 / 7	0.37	0.403		1.2E+01 ✓
Barium	0.021	7 / 7	0.034	NA		NC
Chromium	0.55	7 / 7	ND	0.03		1.8E+01 ✓
Cobalt	0.01	1 / 7	ND	0.05		2.0E-01
Hexavalent Chromium	0.052	2 / 2	ND	0.03	[d]	1.7E+00 ✓
Iron	2.06	7 / 7	1.8	1	[e]	2.1E+00 ✓
Manganese	0.90	7 / 7	3.4	1.42		6.4E-01
Zinc	0.062	7 / 7	0.048	0.01		6.2E+00 ✓
Inorganics (mg/L)						
Chloride	150	7 / 7	110	230	[e]	6.5E-01
Nitrate as N	6.2	2 / 2	NA	NA		NC
Nitrite as N	0.21	2 / 2	NA	NA		NC
Nitrogen, Ammonia	45	7 / 7	NA	2.2	[e]	2.0E+01 ✓
Sulfate as SO4	379	7 / 7	24	NA		NC
			HAZARD INDEX			7.8E+01

NOTES:
[a] OHMPC selection presented in Table 3.
[b] Exposure point concentration is the arithmetic mean of all sample results with 1/2 the SQL used for nondetects. Some averages may exceed maximum concentrations due to elevated SQLs, in which case the maximum detected concentration was used as the exposure point concentration. (Identified with an "*")
[c] Aquatic RTVs for surface water are presented in Table 30.
[d] Value for chromium used as a surrogate.
[e] Amphibian toxicity data not available for this CPC. Value shown is chronic freshwater AWQC.
Hazard Quotient calculated by dividing the exposure point concentration by the RTV.
Hazard Index calculated by summing all HQs.
NA = Not available
NB = Not considered a background analyte
NC = Not calculated
ND = Not detected in background samples

TABLE 44
COMPARISON OF SURFACE WATER OHMPC CONCENTRATIONS WITH AQUATIC RTVs [a]
SOUTH DITCH (UNFILTERED, RECENT) - AQUATIC DITCH HABITAT

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

ANALYTE	EXPOSURE POINT CONCENTRATION [b]	FREQUENCY OF DETECTION		BKGD MAX	AQUATIC RTV [c]		HAZARD QUOTIENT
SURFACE WATER							
Metals (mg/L)							
Aluminum	0.85	3 /	3	0.37	0.403		2.1E+00
Barium	0.025	3 /	3	0.034	NA		NC
Chromium	0.017	2 /	3	ND	0.03	[d]	5.6E-01
Iron	1.5	2 /	3	1.8	1	[e]	1.5E+00
Manganese	0.50	3 /	3	0.1	1.42		3.5E-01
Inorganics (mg/L)							
Chloride	120	3 /	3	110	230	[e]	5.2E-01
Nitrate as N	4.7	3 /	3	NA	NA		NC
Nitrogen, Ammonia	60	3 /	3	NA	2.2	[e]	2.7E+01
Sulfate as SO4	640	3 /	3	24	NA		NC
				HAZARD INDEX			3.2E+01

NOTES:

[a] CPC selection presented in Table 2.

[b] Exposure point concentration is the arithmetic mean of all sample results with 1/2 the SQL used for nondetects. Some averages may exceed maximum concentrations due to elevated SQLs, in which case the maximum detected concentration was used as the exposure point concentration. (Identified with an "*")

[c] Aquatic RTVs for surface water are presented in Table 30.

[d] Value for chromium used as a surrogate.

[e] Amphibian toxicity data not available for this CPC. Value shown is chronic freshwater AWQC.

Hazard Quotient calculated by dividing the exposure point concentration by the RTV.

Hazard Index calculated by summing all HQs.

NA = Not available

NC = Not calculated

TABLE 45
COMPARISON OF SURFACE WATER OHMPC CONCENTRATIONS WITH AQUATIC RTVs [a]
EPHEMERAL DRAINAGE (UNFILTERED, HISTORICAL) - AQUATIC HABITAT

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

ANALYTE	EXPOSURE POINT CONCENTRATION [b]	FREQUENCY OF DETECTION	BKGD MAX	AQUATIC RTV [c]		HAZARD QUOTIENT
SURFACE WATER						
SVOCs (mg/L)						
Di-n-octylphthalate	0.0053	1 / 3	NB	0.00032		1.7E+01
bis(2-EthylHexyl)phthalate	0.0047	2 / 3	NB	3.38		1.4E-03
Metals (mg/L)						
Aluminum	9.4	3 / 3	0.37	0.403		2.3E+01
Arsenic	0.085	1 / 3	ND	1		8.5E-02
Barium	0.038	3 / 3	0.034	NA		NC
Chromium	0.048	1 / 3	ND	0.03		1.6E+00
Cobalt	0.012	1 / 3	ND	0.05		2.3E-01
Iron	26	3 / 3	1.8	1	[d]	2.6E+01
Lead	0.062	1 / 3	ND	0.47		1.3E-01
Manganese	0.70	3 / 3	0.1	1.42		4.9E-01
Mercury	0.0004	1 / 3	ND	0.0013		3.1E-01
Vanadium	0.072	1 / 3	ND	NA		NC
Zinc	0.074	3 / 3	0.048	0.01		7.4E+00
Inorganics (mg/L)						
Chloride	18	3 / 3	110	230	[d]	NC
Nitrogen, Ammonia	1.01	2 / 3	NA	2.2	[d]	4.6E-01
Sulfate as SO4	220	3 / 3	24	NA		NC
			HAZARD INDEX			7.6E+01

NOTES:

[a] OHMPC selection presented in Table 3.

[b] Exposure point concentration is the arithmetic mean of all sample results with 1/2 the SQL used for nondetects. Some averages may exceed maximum concentrations due to elevated SQLs, in which case the maximum detected concentration was used as the exposure point concentration. (Identified with an "*")

[c] Aquatic RTVs for surface water are presented in Table 30.

[d] Amphibian toxicity data not available for this CPC. Value shown is chronic freshwater AWQC.

Hazard Quotient calculated by dividing the exposure point concentration by the RTV.

Hazard Index calculated by summing all HQs.

NA = Not available

NB = Not considered a background analyte

NC = Not calculated

ND = Not detected in background samples

TABLE 46
COMPARISON OF SURFACE WATER OHMPC CONCENTRATIONS WITH AQUATIC RTVs [a]
EPHEMERAL DRAINAGE (UNFILTERED, RECENT) - AQUATIC HABITAT

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

ANALYTE	EXPOSURE POINT CONCENTRATION [b]	FREQUENCY OF DETECTION	BKGD MAX	AQUATIC RTV [c]		HAZARD QUOTIENT
SURFACE WATER						
Metals (mg/L)						
Aluminum	2.4	1 / 1	0.37	0.403		6.0E+00 ✓
Barium	0.032	1 / 1	0.034	NA		NC
Iron	0.75	1 / 1	1.8	1	[d]	7.5E-01
Manganese	0.56	1 / 1	0.1	1.42		3.9E-01
Inorganics (mg/L)						
Chloride	24	1 / 1	110	230	[d]	NC
Nitrate as N	0.25	1 / 1	NA	NA		NC
Nitrogen, Ammonia	2.0	1 / 1	NA	2.2	[d]	9.1E-01
Sulfate as SO4	130	1 / 1	24	NA		NC
			HAZARD INDEX			8.0E+00

NOTES:

[a] CPC selection presented in Table 2.

[b] Exposure point concentration is the arithmetic mean of all sample results with 1/2 the SQL used for nondetects. Some averages may exceed maximum concentrations due to elevated SQLs, in which case the maximum detected concentration was used as the exposure point concentration. (Identified with an "*")

[c] Aquatic RTVs for surface water are presented in Table 30.

[d] Amphibian toxicity data not available for this CPC. Value shown is chronic freshwater AWQC.

Hazard Quotient calculated by dividing the exposure point concentration by the RTV.

Hazard Index calculated by summing all HQs.

NA = Not available

NC = Not calculated

TABLE 47
COMPARISON OF SURFACE WATER OHMPC CONCENTRATIONS WITH AQUATIC RTVs [a]
CENTRAL POND (UNFILTERED, RECENT) - AQUATIC HABITAT

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

ANALYTE	EXPOSURE POINT CONCENTRATION [b]	FREQUENCY OF DETECTION	BKGD MAX	AQUATIC RTV [c]	HAZARD QUOTIENT
SURFACE WATER					
Metals (mg/L)					
Aluminum	0.84	1 / 1	0.37	0.403	2.1E+00
Barium	0.02	1 / 1	0.034	NA	NC
Chromium	0.02	1 / 1	ND	0.03	6.7E-01
Iron	0.082	1 / 1	1.8	1 [d]	8.2E-02
Manganese	0.23	1 / 1	0.1	1.42	1.6E-01
Inorganics (mg/L)					
Chloride	42	1 / 1	110	230 [d]	NC
Nitrate as N	6.8	1 / 1	NA	NA	NC
Nitrite as N	6.8	1 / 1	NA	NA	NC
Sulfate as SO4	630	1 / 1	24	NA	MC
				HAZARD INDEX	3.0E+00

NOTES:

[a] OHMPC selection presented in Table 2.

[b] Exposure point concentration is the arithmetic mean of all sample results with 1/2 the SQL used for nondetects. Some averages may exceed maximum concentrations due to elevated SQLs, in which case the maximum detected concentration was used as the exposure point concentration. (Identified with an "*")

[c] Aquatic RTVs for surface water are presented in Table 30.

[d] Amphibian toxicity data not available for this CPC. Value shown is chronic freshwater AWQC.

Hazard Quotient calculated by dividing the exposure point concentration by the RTV.

Hazard Index calculated by summing all HQs.

NA = Not available

NC = Not calculated

ND = Not detected in background samples

TABLE 48
SUMMARY OF FINDINGS FOR AQUATIC RECEPTORS

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

	Sediment			Surface Water/Amphibian RTV				General
	FETAX Results		Pop. Model	Historical		Recent		Field Observations
Location	% Survival	% Normal [a]	> 25 % Reduction? [b]	HI	OHMPC Contributing	HI	OHMPC Contributing	Presence (+)/Absence (-) of Amphibians
Off-property West Ditch	68	38	No/Yes	170	Cr, NH4, Al	4.3	Fe, NH4	- [c]
On-property West Ditch	52* 34*	10* 0*	No/Yes Yes/Yes	3.8	Zn	NA	NA	+
South Ditch	78 76	56 66	No/Yes No/Yes	78	NH4, Cr, Al, di-n-o-phth	33	NH4	+
Ephemeral Drainage	NA	NA	NA	76	di-n-o-phth, Al, Fe	8	Al	+
Pond	60 78	36 44	No/Yes No/Yes	NA	NA	3	Al	+
Ref. Location	80	58	No/Yes	NA	NA	NA	NA	NA

Notes:
* Significantly different from reference location
NA Not Available
[a] According to FETAX protocol, % normal development is calculated as follows:
% normal = (total# test organisms - # dead organisms - # malformed organisms)/total # test organisms * 100
Therefore, assuming that malformed organisms do not live to maturity, % normal development is actually a more accurate representation of survival for use in the population model.
[b] If toxicity occurs before/after density dependence. Most likely toxicity occurs before density dependence.
[c] Off-property West Ditch was not easily accessible due to chain link/barbed wire fencing.

TABLE 49
GREEN FROG RISK EVALUATION SUMMARY

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

Media	Receptor	Assessment Endpoint	Measurement Endpoints	Potentially Significant Risk
Surface Water / Sediment	Green frog	Reduction in resident amphibian population size	• Statistically significant (relative to reference location) laboratory toxicity of embryo African clawed frogs following 96-hr sediment elutriate exposures [A]	Yes (On-Property West Ditch)
			• Population model - 25% decrease in abundance presumed significant. [B]	Yes (On-Property West Ditch)
			• Field observations of presence/absence of amphibians [C]	No
			• Comparison of published amphibian toxicity data [D]	
			- to surface water data	Yes
			- to sediment data	NA

WEIGHT OF EVIDENCE

Measurement Result	High Weight	Medium Weight	Low Weight
Yes, Strong		A,B	
Yes, Weak		D	
Indeterminate			
No, Weak	C		
No, Strong			

TABLE 50
HAZARD INDEX (HI) SUMMARY TABLE

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

	Wildlife HIs		
AREA	**American Woodcock**	**Red Fox**	**Green Heron**
Terrestrial	1.9E+00	5.8E-02	
Semi-aquatic			
Central Pond			1.1E-01
South Ditch			1.7E-01
Ephemeral Drainage			4.5E-02
On-property West Ditch			5.7E-01
Off-property West Ditch			6.2E-02
Total HI			**9.6E-01**

Notes:
SW = Surface water
Spreadsheets with exposure and risk calculations for wildlife receptors are presented in Attachment 4, Tables A4-4 through A4-9.

TABLE 51
GREEN HERON RISK EVALUATION SUMMARY

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

Media	Receptor	Assessment Endpoint	Measurement Endpoints	Potentially Significant Risk
Sediment/ Surface Water	Green heron	• Reduction in heron subpopulation size from food chain exposure	• Direct toxicity estimated by comparing published avian ingestion toxicity data to predicted dietary exposures based on measured prey (i.e., small mammal, crayfish and frog) tissue concentrations	No
		• Reduction in heron subpopulation from indirect impacts associated with decreased prey abundance	• Based on frog population modeling and measured laboratory toxicity of embryo African clawed frogs. Fifty percent decrease in abundance of frog population presumed significant.	No

TABLE 52
COMPARISON OF SURFACE SOIL OHMPC CONCENTRATIONS WITH TERRESTRIAL RTVs [a]
TERRESTRIAL HABITAT

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

ANALYTE	EXPOSURE POINT CONCENTRATION	FREQUENCY OF DETECTION	BKGD MAX	TERRESTRIAL INVERTEBRATE RTV [b]	HAZARD QUOTIENT
SURFACE SOIL					
VOCs (mg/kg)					
1,1,1-Trichloroethane	0.014	15 / 39	NA	150	9.6E-05
1,1-Dichloroethene	0.0012	1 / 39	NA	150 [c]	7.7E-06
2,4,4-Trimethyl-1-pentene	0.0013	5 / 39	NA	NA	NC
Acetone	0.019	29 / 39	NA	NA	NC
Methylene Chloride	0.0077	13 / 39	NA	150	5.1E-05
Tetrachloroethene (PCE)	0.0028	3 / 39	NA	150	1.9E-05
Toluene	0.0038	8 / 39	NA	20	1.9E-04
SVOCs (mg/kg)					
2-Methylnaphthalene	8.4	3 / 35	NA	34	2.5E-01
Acenaphthene	2.6	1 / 35	NA	34	7.7E-02
Acenaphthylene	6.3	4 / 35	NA	34	1.9E-01
Anthracene	4.4	9 / 35	NA	34	1.3E-01
Benzo(a)Anthracene	2.2	10 / 35	NA	34	6.5E-02
Benzo(a)Pyrene	1.6	7 / 35	NA	34	4.8E-02
Benzo(b)Fluoranthene	0.82	9 / 35	0.062	34	2.4E-02
Benzo(g,h,i)Perylene	0.55	2 / 35	NA	34	1.6E-02
Benzo(k)Fluoranthene	1.1	9 / 35	NA	34	3.3E-02
Benzoic Acid	0.69	13 / 35	NA	NA	NC
Butylbenzylphthalate	0.32	2 / 34	NA	630	5.1E-04
Chrysene	2.4	10 / 35	NA	34	7.0E-02
Di-n-butylphthalate	0.75	23 / 34	NA	630	1.2E-03
Di-n-octylphthalate	0.18	3 / 34	NA	630	2.8E-04
Dibenzofuran	0.70	1 / 35	NA	NA	NC
Diethylphthalate	0.042	12 / 35	NA	630	6.7E-05
Fluoranthene	6.2	16 / 35	0.066	34	1.8E-01
Fluorene	6.5	2 / 35	NA	34	1.9E-01
Indeno (1,2,3-cd)Pyrene	0.49	6 / 35	NA	34	1.4E-02
N-Nitrosodiphenylamine (1)	1.3	7 / 33	NA	6	2.1E-01
Naphthalene	8.3	4 / 34	NA	34	2.5E-01
Phenanthrene	16	15 / 34	0.043	34	4.6E-01
Phenol	0.74	1 / 34	NA	8	9.3E-02
Pyrene	5.07	17 / 34	0.065	34	1.5E-01
bis(2-EthylHexyl)phthalate	140	29 / 34	NA	630	2.2E-01
Pesticides/PCBs (mg/kg)					
4,4'-DDD	0.0015	10 / 36	NA	12	1.2E-04
4,4'-DDE	0.0031	17 / 36	NA	12	2.6E-04
4,4'-DDT	0.070	20 / 36	NA	12	5.8E-03
Aldrin	0.00096	4 / 36	NA	2.2	4.4E-04
Alpha-BHC	0.0070	5 / 36	NA	8	8.7E-04
Alpha-Chlordane	0.0029	5 / 36	NA	NA	NC
Dieldrin	0.0018	12 / 36	NA	30	5.9E-05
Endosulfan I	0.0027	3 / 36	NA	1	2.7E-03
Endosulfan II	0.019	2 / 36	NA	1	1.9E-02
Gamma-BHC (Lindane)	0.0055	12 / 36	NA	8	6.9E-04
Gamma-Chlordane	0.0018	3 / 36	NA	NA	NC
Heptachlor Epoxide	0.00017	3 / 36	NA	6.4	2.7E-05

TABLE 52
COMPARISON OF SURFACE SOIL OHMPC CONCENTRATIONS WITH TERRESTRIAL RTVs [a]
TERRESTRIAL HABITAT

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

ANALYTE	EXPOSURE POINT CONCENTRATION	FREQUENCY OF DETECTION	BKGD MAX	TERRESTRIAL INVERTEBRATE RTV [b]	HAZARD QUOTIENT
SURFACE SOIL					
PCB-1016	0.087	1 / 8	NA	NA	NC
Metals (mg/kg)					
Aluminum	6600	23 / 23	7900	NA	NC
Antimony	7.5	5 / 23	NA	NA	NC
Arsenic	7.05	21 / 23	7.1	100	7.1E-02
Barium	16	23 / 23	22	NA	NC
Beryllium	0.208	1 / 23	NA	NA	NC
Cadmium	0.25	1 / 23	NA	50	5.1E-03
Chromium	520	36 / 36	16	50	1.0E+01
Cobalt	3.1	20 / 23	3.7	NA	NC
Copper	9.0	23 / 23	6.4	30	3.0E-01
Cyanide	0.96	2 / 8	NA	NA	NC
Lead	39	23 / 23	11	1190	3.3E-02
Manganese	50	23 / 23	150	NA	NC
Mercury	0.29	12 / 23	NA	36	8.1E-03
Nickel	6.4	23 / 23	6.5	400	1.6E-02
Selenium	0.52	7 / 23	NA	NA	NC
Thallium	0.68	3 / 23	NA	NA	NC
Vanadium	15	23 / 23	16	NA	NC
Zinc	27	23 / 23	21	130	2.1E-01
Inorganics (mg/kg)					
Chloride	120	6 / 8	NA	NA	NC
Nitrogen, Ammonia	160	28 / 28	37	NA	NC
Sulfate as SO4	2500	26 / 28	30	NA	NC
			HAZARD INDEX		**1.4E+01**

NOTES:

[a] OHMPC selection presented in Table 1.

[b] Terrestrial RTVs for surface soil are presented in Table 35.

[c] Value for 1,2-Dichloroethene (total) used as surrogate.

Hazard Quotient calculated by dividing the average CPC concentrations by the RTV.

Hazard Index calculated by summing all HQs.

NA = Not available

NC = Not calculated

TABLE 53
EARTHWORM TOXICITY TEST AND SURFACE SOIL ANALYTICAL RESULTS
(SVOCs, Pesticides, and Metals)

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

SAMPLE LOCATIONS		BS013WDXX	BS014WDXX	BS015SDXX	BSO16SMDX	BS017PNDX	BS018PNDX	BS019WMDX	BS020WMDX	BS021REFX
TOXICITY TEST RESULTS										
Mean Percent Survival		100%	100%	100%	98%	100%	100%	100%	98%	100%
Mean Weight (Grams)		0.367	0.371	0.357	0.304	0.362	0.341	0.38	0.324	0.376
Statistically significant from										
Control, Survival/Growth		No/No	No/No	No/No	No/Yes	No/No	No/No	No/No	No/No	No/No
Reference, Survival/Growth		No/No	No/No	No/No	No/Yes	No/No	No/No	No/No	No/Yes	No/No
ANALYTICAL RESULTS SVOCs (mg/kg)	**TERRESTRIAL RTV [a]**									
2-Methylnaphthalene	34	0.4 U	0.52 U	32 U	5 U	1.8 U	0.007 J	0.49 U	0.48 U	5 U
2-Methylphenol	8 [b]	0.4 U	0.52 U	32 U	5 U	1.8 U	0.02 J	0.49 U	0.48 U	5 U
Anthracene	34	0.002 J	0.52 U	32 U	0.035 J	0.01 J	0.013 J	0.005 J	0.48 U	0.027 J
Benzo(a)anthracene	34	0.008 J	0.52 U	32 U	5 U	1.8 U	0.031 J	0.012 J	0.48 U	5 U
Benzo(a)pyrene	34	0.4 U	0.52 U	32 U	5 U	1.8 U	0.034 J	0.011 J	0.48 U	5 U
Benzo(b)fluoranthene	34	0.01 J	0.52 U	32 U	5 U	1.8 U	0.044 J	0.013 J	0.48 U	5 U
Benzo(g,h,i)perylene	34	0.4 U	0.52 U	32 U	5 U	1.8 U	0.03 J	0.49 U	0.48 U	5 U
Benzo(k)fluoranthene	34	0.006 J	0.52 U	32 U	5 U	1.8 U	0.025 J	0.012 J	0.48 U	5 U
Benzoic acid	NA	0.039 J	0.1 J	160 U	24 U	8.8 U	0.59 J	0.36 J	0.24 J	24 U
bis(2-Ethylhexyl)phthalate	630	0.96 B	0.47 JB	200 B	20 B	8.6 B	1.7 B	0.32 JB	0.35 JB	18 B
Chrysene	34	0.012 J	0.52 U	32 U	5 U	1.8 U	0.049 J	0.016 J	0.48 U	5 U
Di-n-butylphthalate	630	0.05 JB	0.02 JB	0.4 JB	0.074 JB	0.046 JB	0.013 JB	0.02 JB	0.013 JB	0.096 JB
Diethylphthalate	630	0.01 JB	0.033 JB	32 U	0.085 JB	0.053 JB	0.015 JB	0.013 JB	0.013 JB	0.08 JB
Fluoranthene	34	0.015 J	0.008 J	32 U	0.081 J	0.037 J	0.067 J	0.026 J	0.011 J	0.092 J
Fluorene	34	0.4 U	0.52 U	32 U	5 U	1.8 U	0.008 J	0.49 U	0.48 U	5 U
Indeno(1,2,3-cd)pyrene	34	0.4 U	0.52 U	32 U	5 U	1.8 U	0.031 J	0.49 U	0.48 U	5 U
N-Nitrosodiphenylamine	6	0.075 J	0.52 U	2.8 J	0.55 J	0.26 J	0.44 U	0.49 U	0.48 U	0.54 J
Naphthalene	34	0.4 U	0.52 U	32 U	5 U	1.8 U	0.008 J	0.49 U	0.48 U	5 U
Phenanthrene	34	0.011 J	0.52 U	32 U	0.14 J	0.044 J	0.06 J	0.019 J	0.012 J	0.11 J
Pyrene	34	0.015 J	0.011 J	32 U	0.085 J	0.039 J	0.061 J	0.02 J	0.013 J	0.095 J
ANALYTICAL RESULTS Pesticides (mg/kg)										
4,4'-DDD	12	0.004 U	0.0052 U	0.065 U	0.005 U	0.00019 J	0.0068	0.00012 J	0.00035 J	0.005 U
4,4'-DDE	12	0.002 J	0.0026 J	0.065 U	0.0037 J	0.0016 J	0.011	0.0026 J	0.0021 J	0.0018 J
4,4'-DDT	12	0.015	0.0023 J	0.065 U	0.0016 J	0.0032 J	0.027	0.0014 J	0.0073	0.0028 J
Aldrin	2.2	0.002 U	0.0027 U	0.033 U	0.000098 J	0.0023 U	0.0023 U	0.0024 U	0.0025 U	0.0026 U
alpha-BHC	8	0.002 U	0.0027 U	0.0058 J	0.0026 U	0.00056 J	0.0023 U	0.0024 U	0.0025 U	0.0026 U

TABLE 53
EARTHWORM TOXICITY TEST AND SURFACE SOIL ANALYTICAL RESULTS
(SVOCs, Pesticides, and Metals)

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

SAMPLE LOCATIONS		BS013WDXX	BS014WDXX	BS015SDXX	BSO16SMDX	BS017PNDX	BS018PNDX	BS019WMDX	BS020WMDX	BS021REFX
TOXICITY TEST RESULTS										
Mean Percent Survival		100%	100%	100%	98%	100%	100%	100%	98%	100%
Mean Weight (Grams)		0.367	0.371	0.357	0.304	0.362	0.341	0.38	0.324	0.376
Statistically significant from										
Control, Survival/Growth		No/No	No/No	No/No	No/Yes	No/No	No/No	No/No	No/No	No/No
Reference, Survival/Growth		No/No	No/No	No/No	No/Yes	No/No	No/No	No/No	No/Yes	No/No
alpha-Chlordane	NA	0.00023 J	0.0027 U	0.033 U	0.0026 U	0.0023 U	0.00079 J	0.0024 U	0.00034 J	0.00016 J
Dieldrin	30	0.004 U	0.00081 J	0.065 U	0.00055 J	0.0004 J	0.0025 J	0.00098 J	0.00087 J	0.005 U
Endrin aldehyde	NA	0.0006 J	0.0052 U	0.065 U	0.005 U	0.0045 U	0.0044 U	0.0046 U	0.0048 U	0.005 U
Endrin ketone	NA	0.004 U	0.0052 U	0.065 U	0.005 U	0.0045 U	0.0044 U	0.0014 J	0.0048 U	0.005 U
gamma-BHC (Lindane)	8	0.002 U	0.00014 J	0.033 U	0.0026 U	0.0014 J	0.00011 J	0.0024 U	0.0025 U	0.0026 U
gamma-Chlordane	NA	0.00029 J	0.0027 U	0.033 U	0.0026 U	0.0023 U	0.00028 J	0.0024 U	0.0025 U	0.0026 U
Heptachlor Epoxide	6.4	0.002 U	0.000073 J	0.033 U	0.0026 U	0.0023 U	0.0023 U	0.0024 U	0.00041 J	0.001 J
ANALYTICAL RESULTS										
Metals (mg/kg)										
Aluminum	NA	8340	2030	3080	9290	4810	2690	4930	5780	4840
Antimony	NA	1.2 B	1.1 U	1.3 U	1.0 U	0.97 U	0.97 U	1.0 U	0.97 U	1.0 U
Arsenic	100	7.5	1.6 U	4.4	4.7	24.5	7.5	5.8	4.4	5.8
Barium	NA	11.5 B	11.9 B	17.7 B	5.4 B	9.2 B	18.3 B	5.3 B	5.4 B	10.5 B
Calcium	NA [c]	388. B	61.1 B	258. B	77.4 B	371. B	302. B	85.7 B	97.4 B	205. B
Chromium	50	480.	3.0	200.	6.1	305.	5.2	4.2	3.5	5.1
Cobalt	NA	1.7 B	0.46 B	1.0 B	0.80 B	1.9 B	0.55 B	0.43 B	0.24 U	0.99 B
Copper	30	6.2	6.8 B	6.2 B	1.7 B	4.3 B	3.7 B	2.5 B	2.1 B	7.9
Iron	NA [c]	6800 *	2310 *	3240 *	6420 *	20000 *	2850 *	7800 *	4150 *	6480 *
Lead	1190	8.2	76.3	24.2	7.5	14.1	18.6	13.7	15.9	32.2
Magnesium	NA [c]	1210	16.4 B	200. B	197. B	325. B	168. B	112. B	84.0 B	422. B
Manganese	NA	43.0	1.7 B	9.3	9.4	99.9	7.2	10.7	3.7	20.4
Mercury	36	0.12 U	0.14 U	0.15	0.10 U	0.12 U	0.093 U	0.12 U	0.11 U	0.11 U
Nickel	400	6.1 B	5.8 B	5.1 B	2.5 B	1.8 B	2.3 B	1.5 B	1.8 B	3.0 B
Potassium	NA [c]	392. BE	61.0 BE	148. BE	57.4 BE	119. BE	128. BE	67.0 BE	46.3 BE	199. BE
Selenium	NA	0.80 U	1.1 U	1.5 B	1.0 U	0.97 U	0.97 U	1.0 U	0.97 U	1.6
Sodium	NA	90.6 BE	57.1 BE	197. BE	49.9 BE	85.4 BE	110. BE	70.6 BE	53.2 BE	106. BE
Vanadium	NA	15.5	14.5	9.8 B	11.0 B	18.4	8.8 B	15.0	11.3 B	15.9
Zinc	130	18.7 E	14.9 E	8.3 E	5.6 E	7.0 E	4.8 BE	5.9 E	5.1 E	15.0 E

TABLE 53
EARTHWORM TOXICITY TEST AND SURFACE SOIL ANALYTICAL RESULTS
(SVOCs, Pesticides, and Metals)

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

SAMPLE LOCATIONS		BS013WDXX	BS014WDXX	BS015SDXX	BSO16SMDX	BS017PNDX	BS018PNDX	BS019WMDX	BS020WMDX	BS021REFX
TOXICITY TEST RESULTS										
Mean Percent Survival		100%	100%	100%	98%	100%	100%	100%	98%	100%
Mean Weight (Grams)		0.367	0.371	0.357	0.304	0.362	0.341	0.38	0.324	0.376
Statistically significant from										
Control, Survival/Growth		No/No	No/No	No/No	No/Yes	No/No	No/No	No/No	No/No	No/No
Reference, Survival/Growth		No/No	No/No	No/No	No/Yes	No/No	No/No	No/No	No/Yes	No/No

Notes:
[a] Terrestrial RTVs for surface soil are presented in Table 35.
[b] Value for 4-Methylphenol used as surrogate.
[c] Essential nutrients

TABLE 54
TERRESTRIAL WILDLIFE RISK EVALUATION SUMMARY

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

Media	Receptor	Assessment Endpoint	Measurement Endpoints	Potentially Significant Risk
Surface Soil	Woodcock	• Reduction in woodcock subpopulation size from food chain exposure	• Direct toxicity estimated by comparing published avian ingestion toxicity data to predicted dietary exposures based on measured prey (i.e., earthworms) tissue concentrations following a 28-day laboratory exposure to surface soil from the site.	No
		• Reduction in woodcock subpopulation size from indirect impacts associated with decreased prey abundance	• Based on earthworm (*Eisenia foetida*) laboratory toxicity (i.e., LC_{50} and EC_{50} [growth and reproduction] following 14- and 21-day exposures, respectively). Fifty percent decrease in abundance of worm population presumed significant. •	No
	Red fox	• Reduction of red fox subpopulation size from food chain exposure	• Direct toxicity estimated by comparing published mammalian ingestion toxicity data to predicted dietary exposures based on measured prey (i.e., small mammals) tissue concentrations.	No

TABLE 55
COMPARISON OF SURFACE WATER OHMPC CONCENTRATIONS WITH APPLICABLE OR SUITABLY ANALOGOUS STANDARDS (ASAS) [a]
OFF-PROPERTY WEST DITCH (UNFILTERED, HISTORICAL) - AQUATIC DITCH HABITAT

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

ANALYTE	EXPOSURE POINT CONCENTRATION [b]	FREQUENCY OF DETECTION	BKGD MAX	ASAS [c]	EPC EXCEEDS ASAS?
SURFACE WATER					
VOCs (mg/L)					
2,4,4-Trimethyl-1-pentene	0.049	3 / 5	NB	NA	NA
2,4,4-Trimethyl-2-pentene	0.021	3 / 5	NB	NA	NA
Acetone	0.016	1 / 5	NB	NA	NA
Bromoform	0.0023	3 / 5	NB	NA	NA
SVOCs (mg/L)					
Di-n-octylphthalate	0.0010 *	1 / 5	NB	NA	NA
N-Nitrosodiphenylamine (1)	0.0095	3 / 5	NB	NA	NA
Phenol	0.0031	4 / 5	NB	NA	NA
bis(2-EthylHexyl)phthalate	0.006 *	1 / 5	NB	NA	NA
Pesticides/PCBs (mg/L)					
Heptachlor Epoxide	0.0001	1 / 5	NA	NA	NA
Metals (mg/L)					
Aluminum	11	4 / 5	0.37	0.087	YES
Barium	0.027	5 / 5	0.034	NA	NA
Chromium	2.7	4 / 5	ND	0.23 [d]	YES
Cobalt	0.037	3 / 5	ND	NA	NA
Copper	0.034	1 / 5	ND	0.0013 [d]	YES
Hexavalent Chromium	0.20	1 / 1	ND	0.011	YES
Iron	7.8	5 / 5	1.8	1	YES
Lead	0.0050	1 / 5	ND	0.0037 [d]	YES
Manganese	1.7	5 / 5	0.1	NA	NA
Nickel	0.044	2 / 5	ND	0.18 [d]	NO
Zinc	0.083	3 / 5	0.048	0.12 [d]	NO
Inorganics (mg/L)					
Chloride	130	5 / 5	110	230	NO
Nitrate as N	0.70	2 / 2	NA	NA	NA
Nitrogen, Ammonia	63	5 / 5	NA	2.2	YES
Sulfate as SO4	430	5 / 5	24	NA	NA

NOTES:

[a] OHMPC selection presented in Table 3.

[b] Exposure point concentration (EPC) is the arithmetic mean of all sample results with 1/2 the SQL used for nondetects. Some averages may exceed maximum concentrations due to elevated SQLs, in which case the maximum detected concentration was used as the exposure point concentration. (Identified with an "*")

[c] ASASs are equivalent to the promulgated chronic freshwater AWQC (USEPA, 1986b et.seq.).

[d] Hardness dependent criteria. Value presented is adjusted based on a calculated site-specific hardness concentration. (Calculated site specific hardness = 113)

NA = Not available

NB = Not considered a background analyte

ND = Not detected in background samples

TABLE 56
COMPARISON OF SURFACE WATER OHMPC CONCENTRATIONS WITH APPLICABLE OR SUITABLY ANALOGOUS STANDARDS (ASAS) [a]
OFF-PROPERTY WEST DITCH (UNFILTERED, RECENT) - AQUATIC DITCH HABITAT

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

ANALYTE	EXPOSURE POINT CONCENTRATION [b]	FREQUENCY OF DETECTION	BKGD MAX	ASAS [c]	EPC EXCEEDS ASAS?
SURFACE WATER					
Metals (mg/L)					
Aluminum	0.16	2 / 3	0.37	0.087	YES
Barium	0.015	3 / 3	0.034	NA	NA
Iron	2.4	2 / 3	1.8	1	YES
Manganese	0.20	3 / 3	0.1	NA	NA
Inorganics (mg/L)					
Chloride	63	3 / 3	110	230	NO
Nitrate as N	0.43	2 / 3	NA	NA	NA
Nitrogen, Ammonia	2.3	2 / 3	NA	3.27 ~~2.2~~	~~YES~~ NO
Sulfate as SO4	36	3 / 3	24	NA	NA

NOTES:

[a] OHMPC selection presented in Table 2.

[b] Exposure point concentration (EPC) is the arithmetic mean of all sample results with 1/2 the SQL used for nondetects. Some averages may exceed maximum concentrations due to elevated SQLs, in which case the maximum detected concentration was used as the exposure point concentration. (Identified with an "*")

[c] ASASs are equivalent to the promulgated chronic freshwater AWQC (USEPA, 1986b et.seq.).

NA = Not available

TABLE 57
COMPARISON OF SURFACE WATER OHMPC CONCENTRATIONS WITH APPLICABLE OR SUITABLY ANALOGOUS STANDARDS (ASAS) [a]
ON-PROPERTY WEST DITCH (UNFILTERED, HISTORICAL) - AQUATIC DITCH HABITAT

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

ANALYTE	EXPOSURE POINT CONCENTRATION [b]	FREQUENCY OF DETECTION	BKGD MAX	ASAS [c]	EPC EXCEEDS ASAS?
SURFACE WATER					
Metals (mg/L)					
Aluminum	0.19	2 / 2	0.37	0.087	YES
Arsenic	0.0085	2 / 2	ND	0.19	NO
Barium	0.0080	2 / 2	0.034	NA	NA
Iron	0.29	2 / 2	1.8	1	NO
Manganese	0.015	2 / 2	0.1	NA	NA
Zinc	0.019	1 / 2	0.048	0.12 [d]	NO
Inorganics (mg/L)					
Chloride	220	2 / 2	110	230	NO
Nitrate as N	6.4	1 / 1	NA	NA	NA
Nitrite as N	0.054	1 / 1	NA	NA	NA
Nitrogen, Ammonia	0.16	1 / 2	NA	2.3 ~~2.2~~	NO
Sulfate as SO4	77	2 / 2	24	NA	NA

NOTES:
[a] OHMPC selection presented in Table 3.
[b] Exposure point concentration (EPC) is the arithmetic mean of all sample results with 1/2 the SQL used for nondetects. Some averages may exceed maximum concentrations due to elevated SQLs, in which case the maximum detected concentration was used as the exposure point concentration. (Identified with an "*")
[c] ASASs are equivalent to the promulgated chronic freshwater AWQC (USEPA, 1986b et.seq.).
[d] Hardness dependent criteria. Value presented is adjusted based on a calculated site-specific hardness concentration. (Calculated site specific hardness = 113)
NA = Not available
ND = Not detected in background samples

TABLE 58
COMPARISON OF SURFACE WATER OHMPC CONCENTRATIONS WITH APPLICABLE OR SUITABLY ANALOGOUS STANDARDS (ASAS) [a]
SOUTH DITCH (UNFILTERED, HISTORICAL) - AQUATIC DITCH HABITAT

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

ANALYTE	EXPOSURE POINT CONCENTRATION [b]	FREQUENCY OF DETECTION	BKGD MAX	ASAS [c]	EPC EXCEEDS ASAS?
SURFACE WATER					
VOCs (mg/L)					
2,4,4-Trimethyl-1-pentene	0.0069	5 / 7	NB	NA	NA
2,4,4-Trimethyl-2-Pentene	0.0039	4 / 7	NB	NA	NA
SVOCs (mg/L)					
Di-n-octylphthalate	0.0049	2 / 7	NB	NA	NA
N-Nitrosodiphenylamine (1)	0.0025 *	5 / 7	NB	NA	NA
Phenol	0.001 *	1 / 7	NB	NA	NA
bis(2-EthylHexyl)phthalate	0.018	5 / 7	NB	NA	NA
Metals (mg/L)					
Aluminum	5.04	7 / 7	0.37	0.087	YES ✓
Barium	0.021	7 / 7	0.034	NA	NA
Chromium	0.55	7 / 7	ND	0.23 [d]	YES ✓
Cobalt	0.01	1 / 7	ND	NA	NA
Hexavalent Chromium	0.052	2 / 2	ND	0.011	YES ✓
Iron	2.06	7 / 7	1.8	1	YES ✓
Manganese	0.90	7 / 7	3.4	NA	NA
Zinc	0.062	7 / 7	0.048	0.12 [d]	NO ✓
Inorganics (mg/L)					
Chloride	150	7 / 7	110	230	NO
Nitrate as N	6.2	2 / 2	NA	NA	NA
Nitrite as N	0.21	2 / 2	NA	NA	NA
Nitrogen, Ammonia	45	7 / 7	NA	2.2	YES ✓
Sulfate as SO4	379	7 / 7	24	NA	NA

NOTES:

[a] OHMPC selection presented in Table 3.

[b] Exposure point concentration (EPC) is the arithmetic mean of all sample results with 1/2 the SQL used for nondetects. Some averages may exceed maximum concentrations due to elevated SQLs, in which case the maximum detected concentration was used as the exposure point concentration. (Identified with an "*")

[c] ASASs are equivalent to the promulgated chronic freshwater AWQC (USEPA, 1986b et.seq.).

[d] Hardness dependent criteria. Value presented is adjusted based on a calculated site-specific hardness concentration. (Calculated site specific hardness = 113)

NA = Not available

NB = Not considered a background analyte

ND = Not detected in background samples

TABLE 59
COMPARISON OF SURFACE WATER OHMPC CONCENTRATIONS WITH APPLICABLE OR SUITABLY ANALOGOUS STANDARDS (ASAS) [a]
SOUTH DITCH (UNFILTERED, RECENT) - AQUATIC DITCH HABITAT

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

ANALYTE	EXPOSURE POINT CONCENTRATION [b]	FREQUENCY OF DETECTION	BKGD MAX	ASAS [c]	EPC EXCEEDS ASAS?
SURFACE WATER					
Metals (mg/L)					
Aluminum	0.85	3 / 3	0.37	0.087	YES ✓
Barium	0.025	3 / 3	0.034	NA	NA
Chromium	0.017	2 / 3	ND	0.42 [d]	NO
Iron	1.5	2 / 3	1.8	1	YES ✓
Manganese	0.50	3 / 3	0.1	NA	NA
Inorganics (mg/L)					
Chloride	120	3 / 3	110	230	NO
Nitrate as N	4.7	3 / 3	NA	NA	NA
Nitrogen, Ammonia	60	3 / 3	NA	2.2	YES ✓
Sulfate as SO4	640	3 / 3	24	NA	NA

NOTES:

[a] OHMPC selection presented in Table 2.

[b] Exposure point concentration (EPC) is the arithmetic mean of all sample results with 1/2 the SQL used for nondetects. Some averages may exceed maximum concentrations due to elevated SQLs, in which case the maximum detected concentration was used as the exposure point concentration. (Identified with an "*")

[c] ASASs are equivalent to the promulgated chronic freshwater AWQC (USEPA, 1986b et.seq.).

[d] Hardness dependent criteria. Value presented is adjusted based on a calculated site-specific hardness concentration. (Calculated site specific hardness = 234)

NA = Not available

ND = Not detected in background samples

TABLE 60
COMPARISON OF SURFACE WATER OHMPC CONCENTRATIONS WITH APPLICABLE OR SUITABLY ANALOGOUS STANDARDS (ASAS) [a] EPHEMERAL DRAINAGE (UNFILTERED, HISTORICAL) - AQUATIC HABITAT

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

ANALYTE	EXPOSURE POINT CONCENTRATION [b]	FREQUENCY OF DETECTION	BKGD MAX	ASAS [c]	EPC EXCEEDS ASAS?
SURFACE WATER					
SVOCs (mg/L)					
Di-n-octylphthalate	0.0053	1 / 3	NB	NA	NA
bis(2-EthylHexyl)phthalate	0.0047	2 / 3	NB	NA	NA
Metals (mg/L)					
Aluminum	9.4	3 / 3	0.37	0.087	YES
Arsenic	0.085	1 / 3	ND	0.19	NO
Barium	0.038	3 / 3	0.034	NA	NA
Chromium	0.048	1 / 3	ND	0.23 [d]	NO
Cobalt	0.012	1 / 3	ND	NA	NA
Iron	26	3 / 3	1.8	1	YES
Lead	0.062	1 / 3	ND	0.0037 [d]	YES
Manganese	0.70	3 / 3	0.1	NA	NA
Mercury	0.0004	1 / 3	ND	0.000012	YES
Vanadium	0.072	1 / 3	ND	NA	NA
Zinc	0.074	3 / 3	0.048	0.12 [d]	NO
Inorganics (mg/L)					
Chloride	18	3 / 3	110	230	NO
Nitrogen, Ammonia	1.01	2 / 3	NA	2.2	NO
Sulfate as SO4	220	3 / 3	24	NA	NA

NOTES:

[a] OHMPC selection presented in Table 3.

[b] Exposure point concentration (EPC) is the arithmetic mean of all sample results with 1/2 the SQL used for nondetects. Some averages may exceed maximum concentrations due to elevated SQLs, in which case the maximum detected concentration was used as the exposure point concentration. (Identified with an "*")

[c] ASASs are equivalent to the promulgated chronic freshwater AWQC (USEPA, 1986b et.seq.).

[d] Hardness dependent criteria. Value presented is adjusted based on a calculated site-specific hardness concentration. (Calculated site specific hardness = 113)

NA = Not available

NB = Not considered a background analyte

ND = Not detected in background samples

TABLE 61
COMPARISON OF SURFACE WATER OHMPC CONCENTRATIONS WITH APPLICABLE OR SUITABLY ANALOGOUS STANDARDS (ASAS) [a]
EPHEMERAL DRAINAGE (UNFILTERED, RECENT) - AQUATIC HABITAT

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

ANALYTE	EXPOSURE POINT CONCENTRATION [b]	FREQUENCY OF DETECTION	BKGD MAX	ASAS [c]	EPC EXCEEDS ASAS?
SURFACE WATER					
Metals (mg/L)					
Aluminum	2.4	1 / 1	0.37	0.087	YES
Barium	0.032	1 / 1	0.034	NA	NA
Iron	0.75	1 / 1	1.8	1	NO
Manganese	0.56	1 / 1	0.1	NA	NA
Inorganics (mg/L)					
Chloride	24	1 / 1	110	230	NO
Nitrate as N	0.25	1 / 1	NA	NA	NA
Nitrogen, Ammonia	2.0	1 / 1	NA	2.2	NO
Sulfate as SO4	130	1 / 1	24	NA	NA

NOTES:

[a] OHMPC selection presented in Table 2.

[b] Exposure point concentration (EPC) is the arithmetic mean of all sample results with 1/2 the SQL used for nondetects. Some averages may exceed maximum concentrations due to elevated SQLs, in which case the maximum detected concentration was used as the exposure point concentration. (Identified with an "*")

[c] ASASs are equivalent to the promulgated chronic freshwater AWQC (USEPA, 1986b et.seq.).

NA = Not available

TABLE 62
COMPARISON OF SURFACE WATER OHMPC CONCENTRATIONS WITH APPLICABLE OR SUITABLY ANALOGOUS STANDARDS (ASAS) [a]
CENTRAL POND (UNFILTERED, RECENT) - AQUATIC HABITAT

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

ANALYTE	EXPOSURE POINT CONCENTRATION [b]	FREQUENCY OF DETECTION	BKGD MAX	ASAS [c]	EPC EXCEEDS ASAS?
SURFACE WATER					
Metals (mg/L)					
Aluminum	0.84	1 / 1	0.37	0.087	YES
Barium	0.02	1 / 1	0.034	NA	NA
Chromium	0.02	1 / 1	ND	0.42 [d]	NO
Iron	0.082	1 / 1	1.8	1	NO
Manganese	0.23	1 / 1	0.1	NA	NA
Inorganics (mg/L)					
Chloride	42	1 / 1	110	230	NO
Nitrate as N	6.8	1 / 1	NA	NA	NA
Nitrite as N	6.8	1 / 1	NA	NA	NA
Sulfate as SO4	630	1 / 1	24	NA	NA

NOTES:
[a] OHMPC selection presented in Table 2.
[b] Exposure point concentration (EPC) is the arithmetic mean of all sample results with 1/2 the SQL used for nondetects. Some averages may exceed maximum concentrations due to elevated SQLs, in which case the maximum detected concentration was used as the exposure point concentration. (Identified with an "*")
[c] ASASs are equivalent to the promulgated chronic freshwater AWQC (USEPA, 1986b et.seq.).
[d] Hardness dependent criteria. Value presented is adjusted based on a calculated site-specific hardness concentration. (Calculated site specific hardness = 234)
NA = Not available
ND = Not detected in background samples

TABLE 63
POTENTIAL SOURCES OF UNCERTAINTY

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

Potential Source	Direction Of Effect	Justification
Uncertainties Associated with Exposure Assessment		
Food chain model exposure parameter assumptions	Unknown	Exposure parameters are based on literature reports or extrapolated from other information. Efforts were made to select exposure parameters representative of a variety of species or feeding guilds, so that exposure estimates are representative of more than a single species.
Limited evaluation of dermal or inhalation exposure pathways	Underestimate	The dermal and inhalation exposure pathways are generally considered insignificant due to protective fur, feathers, and chitinous exoskeletons, and the low concentration of contaminants under natural atmospheric conditions. However, under certain conditions, these exposure pathways may occur.
Use of unfiltered surface water samples	Overestimate	Measurement of CPC concentrations in unfiltered samples includes both dissolved and particulate fractions. The dissolved fraction is considered to be the biologically available component.
Non-detects assigned a value equal to one-half the SQL	Unknown	Analytes could be present at a concentration anywhere between zero and the SQL.
Uncertainties Associated with Effects		
Extrapolation from test species to representative wildlife species	Unknown	Species differ with respect to absorption, metabolism, distribution, and excretion of chemicals. The magnitude and direction of the difference will vary with each chemical.
Lack of toxicity information for reptile species	Unknown	Information is not available on the toxicity of contaminants to reptile species resulting from dietary or oral exposures. It is assumed that if mammals and birds are protected then reptiles should be protected also.

TABLE 63
POTENTIAL SOURCES OF UNCERTAINTY

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

Potential Source	Direction Of Effect	Justification
<u>Uncertainties Associated with Risk Characterization</u>		
Multiple conservative assumptions	Overestimate	Cumulative impact of multiple conservative assumptions yields a conservative estimate of risk to ecological receptors, and may result in prediction of potential risks at background concentrations or the prediction of risks when there is no potential for adverse effects.

Notes:

CPC = contaminant of potential concem.
RTVs = reference toxicity values.
HIs = hazard indices.

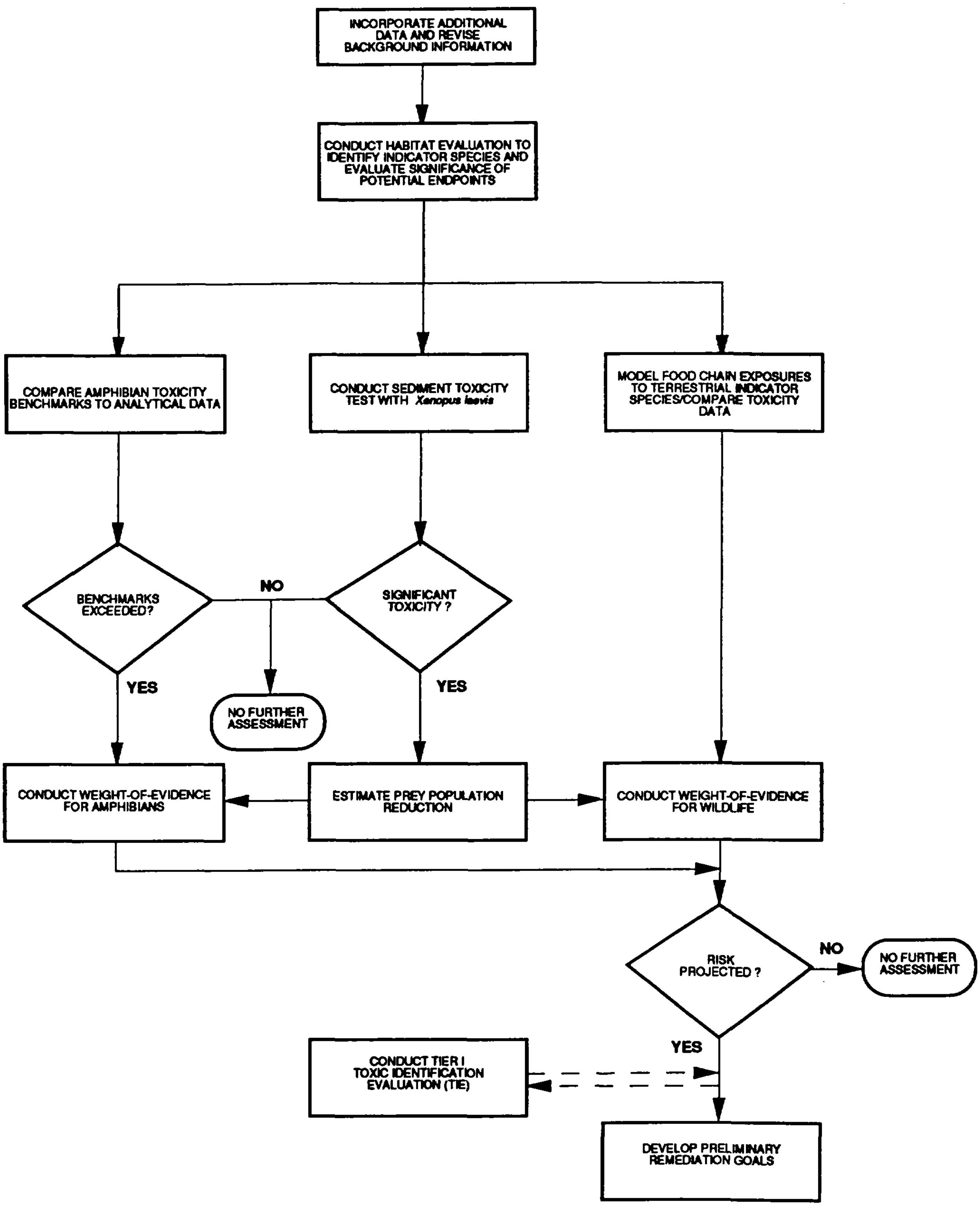

FIGURE 1
PROCESS FLOW DIAGRAM - AQUATIC
METHOD 3, STAGE II
ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION - WILMINGTON PROPERTY
WILMINGTON, MA

7331-87 C

ABB Environmental Services, Inc.

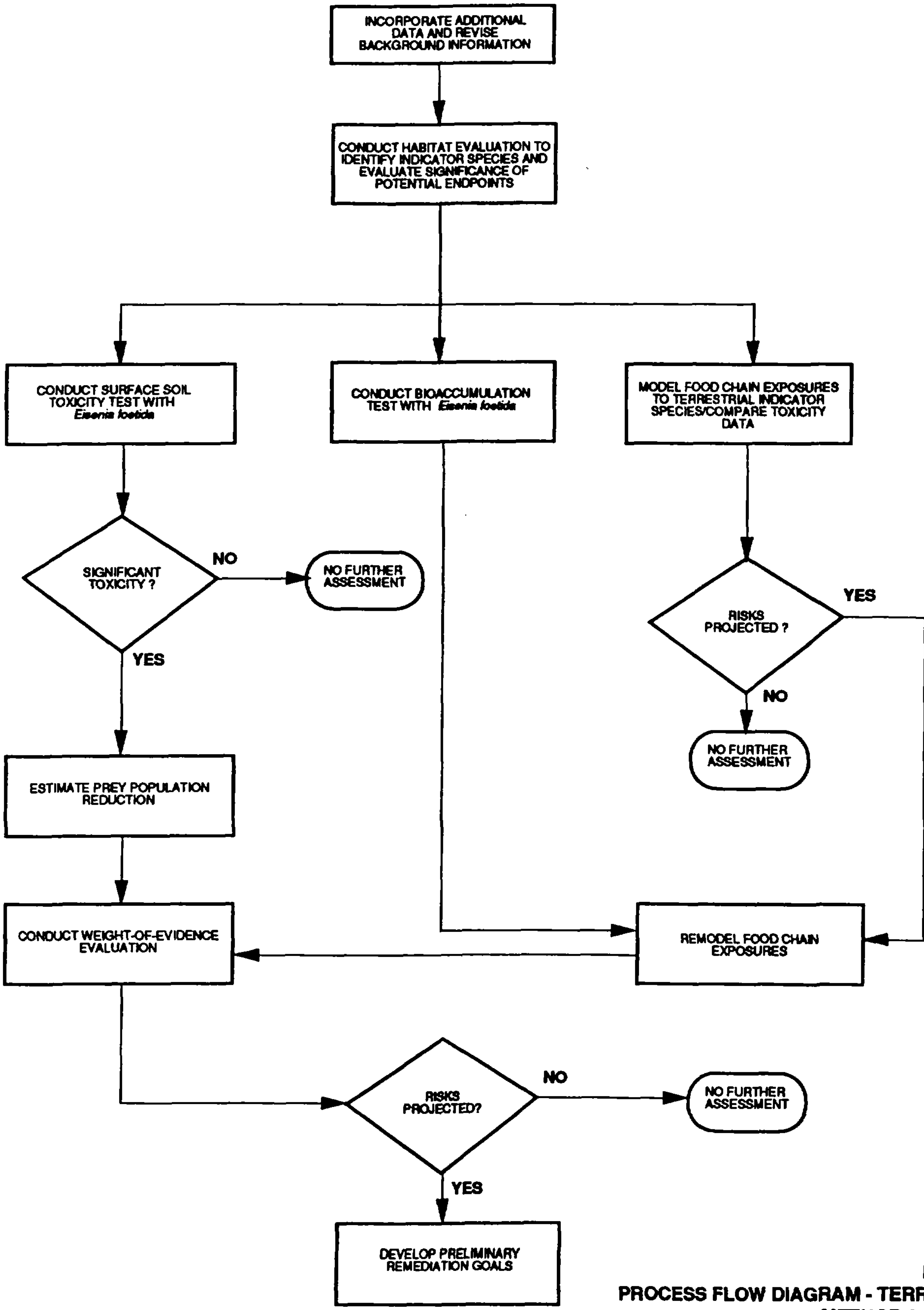

FIGURE 2
PROCESS FLOW DIAGRAM - TERRESTRIAL
METHOD 3, STAGE II
ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION - WILMINGTON PROPERTY
WILMINGTON, MA

ABB Environmental Services, Inc.

7331-67 C

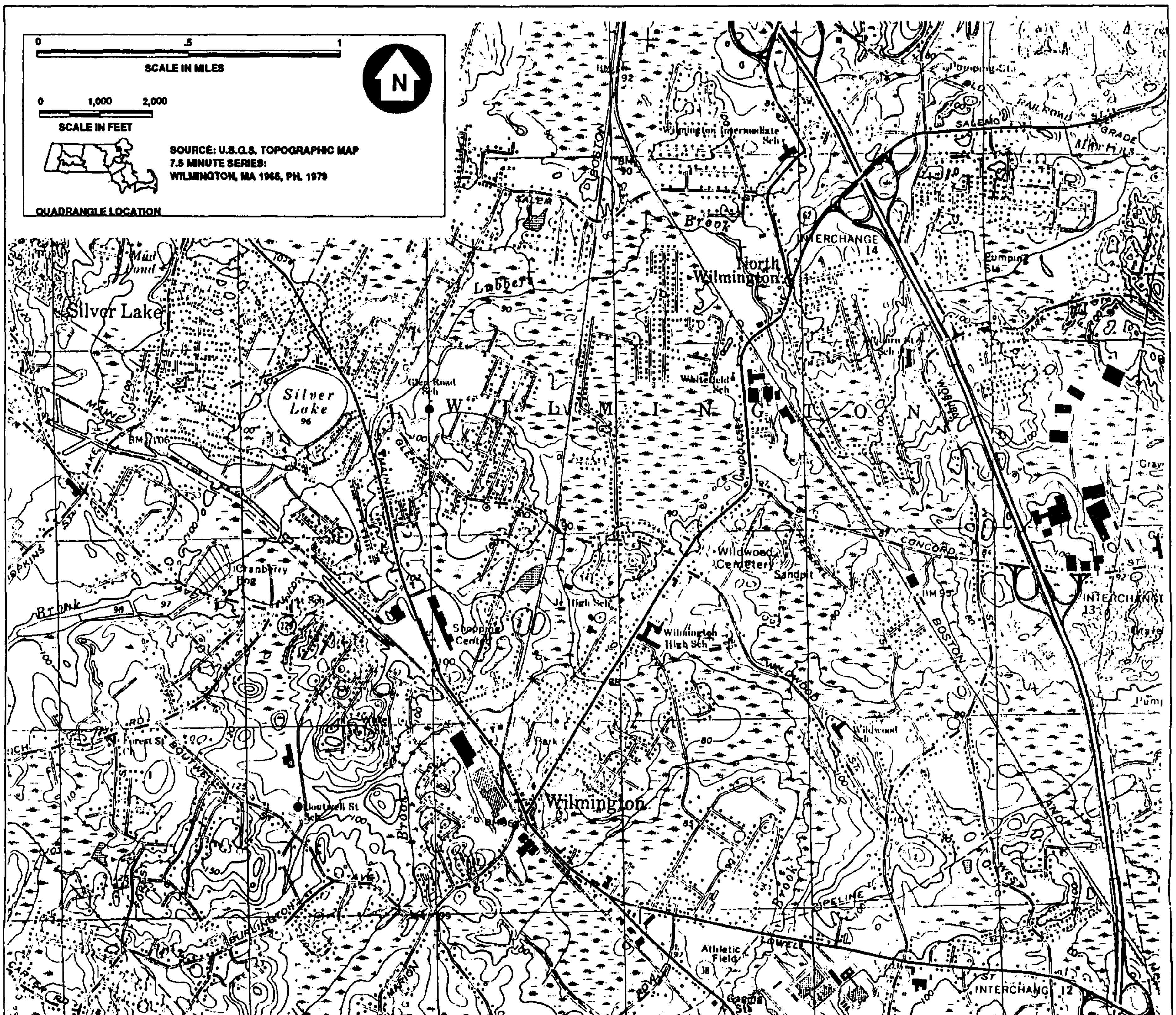

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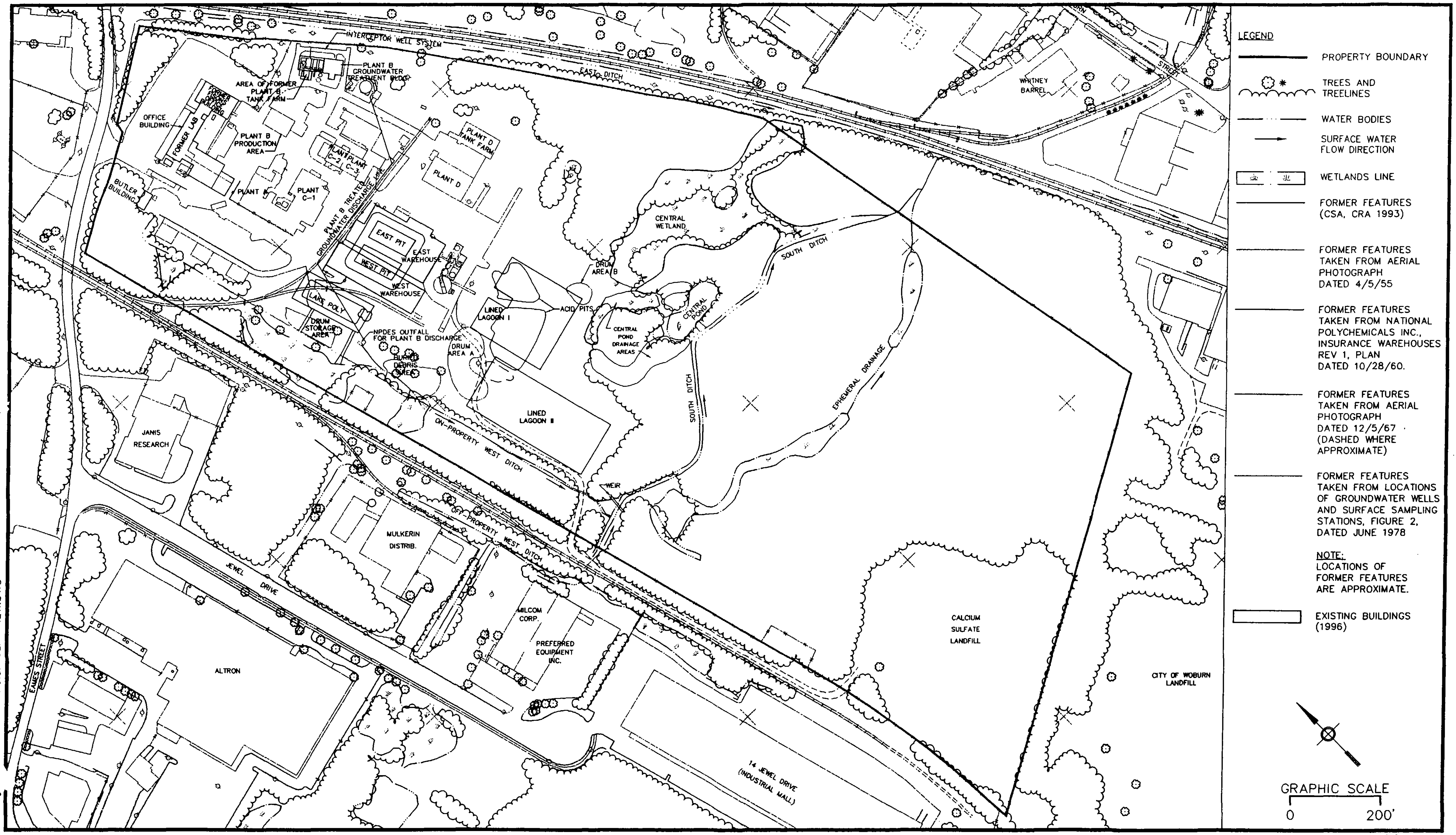
FIGURE 3
PROPERTY LOCATION MAP
OLIN CORPORATION
WILMINGTON, MASSACHUSETTS

SMITH TECHNOLOGY CORPORATION

Olin Corporation
Wilmington, Massachusetts



Project No. 00-7074-0102
May 30, 1997

Figure 4
Site Features Map

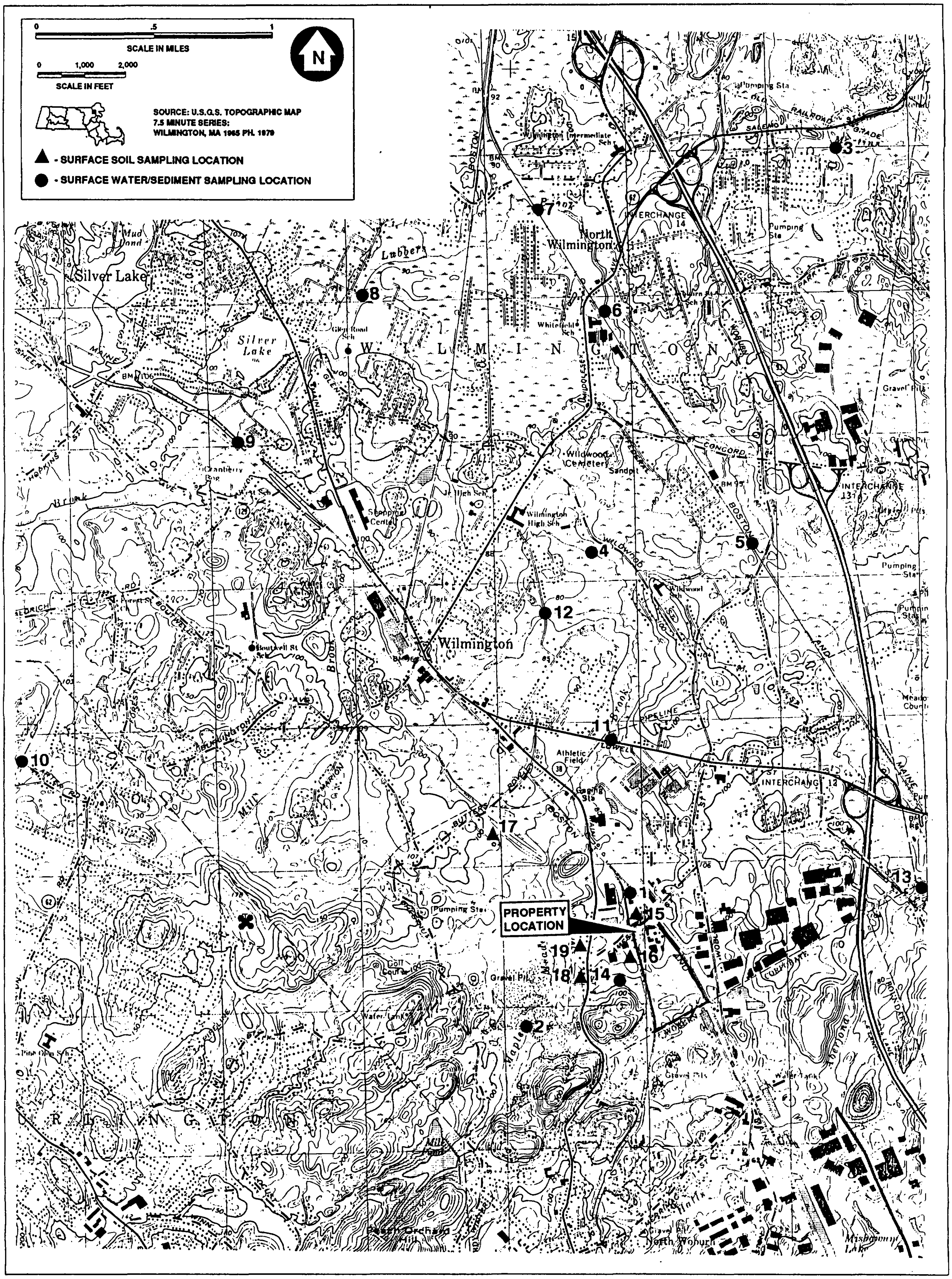
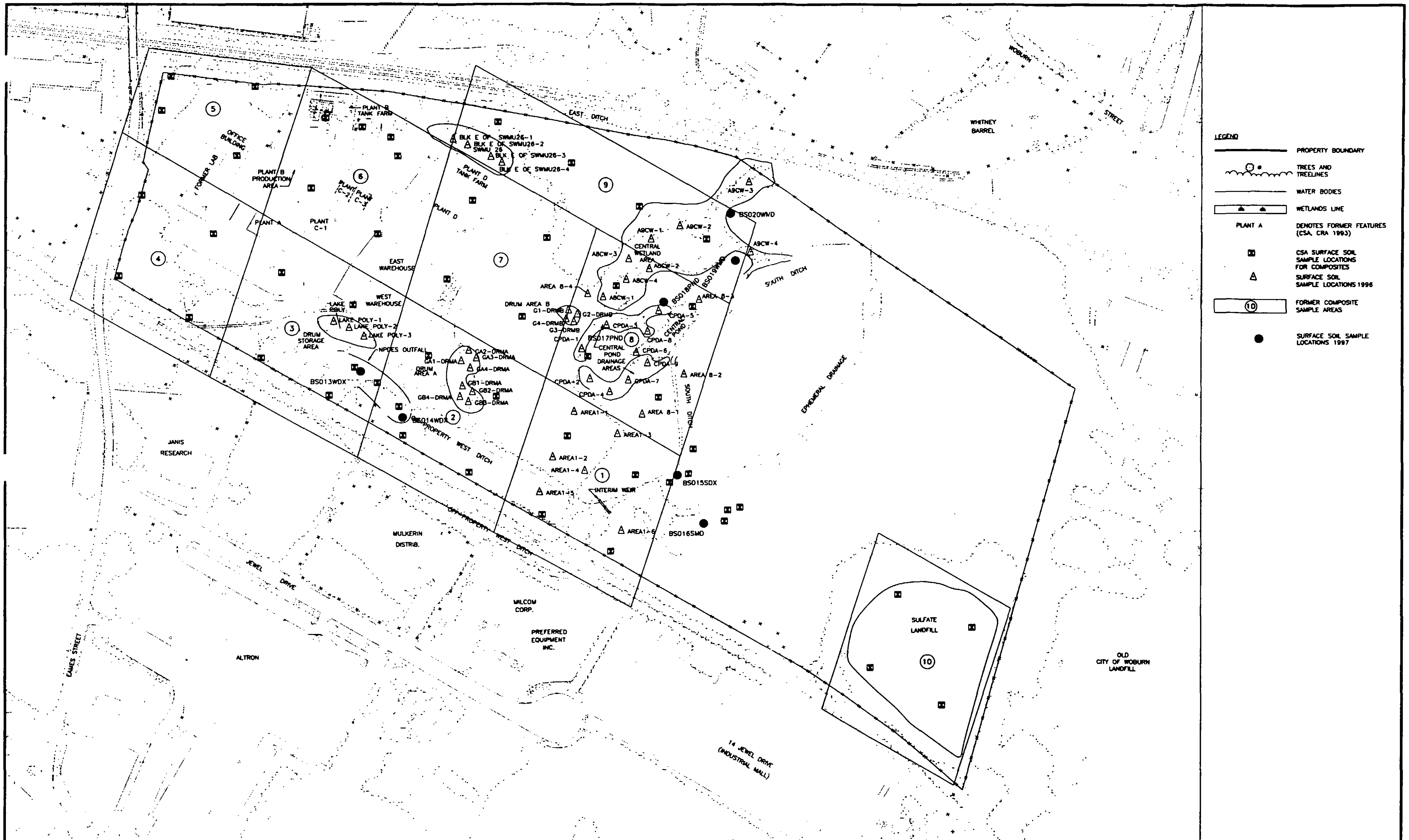


FIGURE 6
BACKGROUND SURFACE SOIL, SURFACE WATER AND SEDIMENT SAMPLING LOCATIONS
OLIN CORPORATION
WILMINGTON, MA

ABB ABB Environmental Services, Inc.



NO	REVISIONS	DATE	ENGR.	DATE	ISSUED FOR

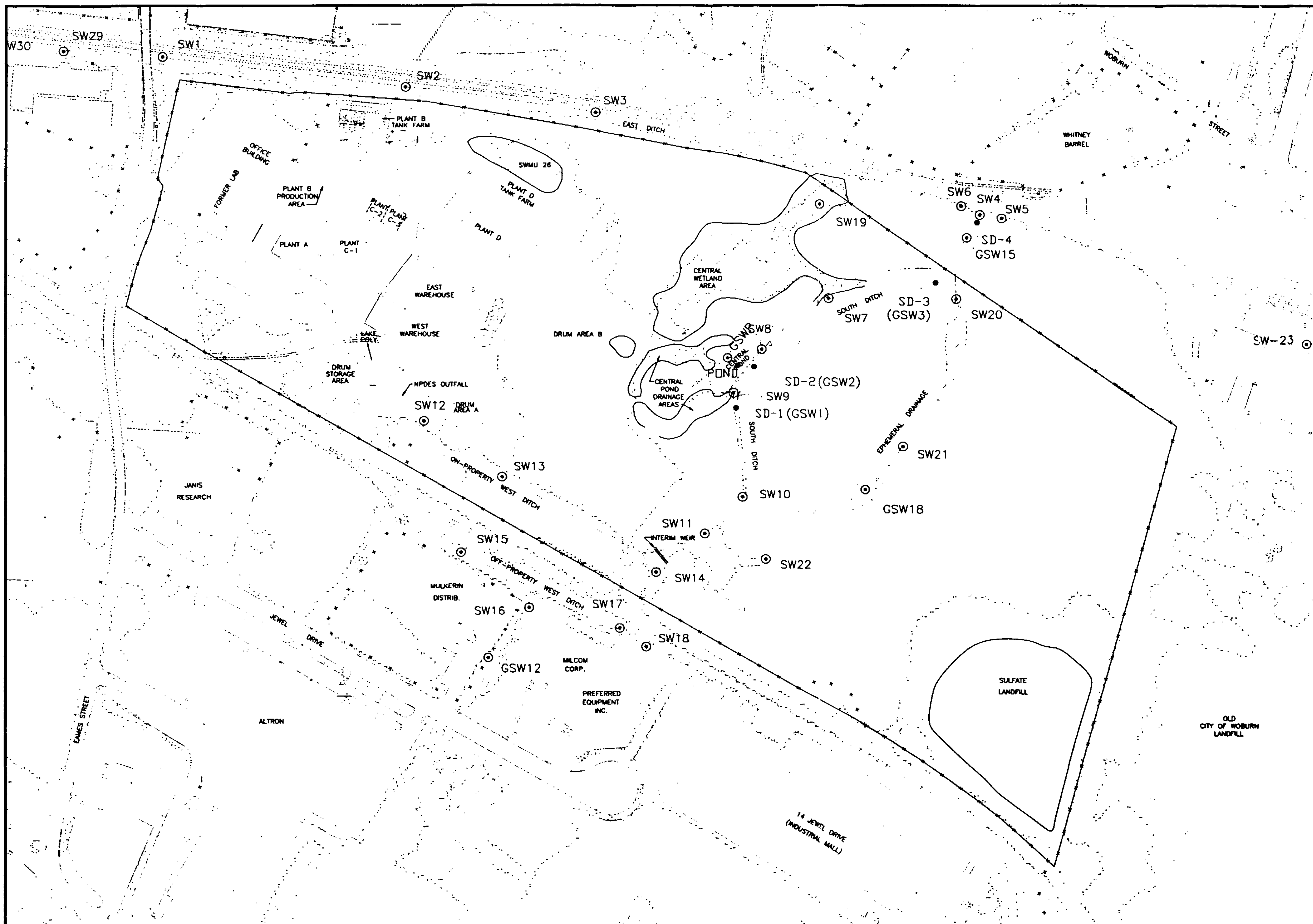
SMITH TECHNOLOGY CORPORATION

PROJECT HYDROGEOLOGIST | APPROVED | SEAL
DRAWN BY
PROJECT GEOLOGIST | APPROVED
PROJECT MGR.
CHECKED BY | DATE
REGISTERED

OLIN CORPORATION
Wilmington, Massachusetts

FIGURE 5
SURFACE SOIL SAMPLE LOCATIONS

SCALE
PROJECT NO.
FIGURE SSLOCS
SHEET



LEGEND

PROPERTY BOUNDARY

TREES AND TREELINES

WATER BODIES

WETLANDS LINE

PLANT A — DENOTES FORMER FEATURES (CSA, CRA 1993)

SURFACE WATER SAMPLING LOCATIONS

NOTE:
SW-24, SW-25 AND SW-26 LOCATED 800 FEET DOWNSTREAM.
SW-27 LOCATED 2,300 FEET DOWNSTREAM.
SW-28 LOCATED 4,900 FEET DOWNSTREAM.

NO.	REVISIONS	DATE	ENGR.	DATE	ISSUED FOR

SMITH
SMITH TECHNOLOGY CORPORATION
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PROJECT HYDROGEOLOGIST	APPROVED	SEAL
DRAWN BY		
PROJECT GEOLOGIST	APPROVED	
PROJECT MGR.		
CHECKED BY	DATE	

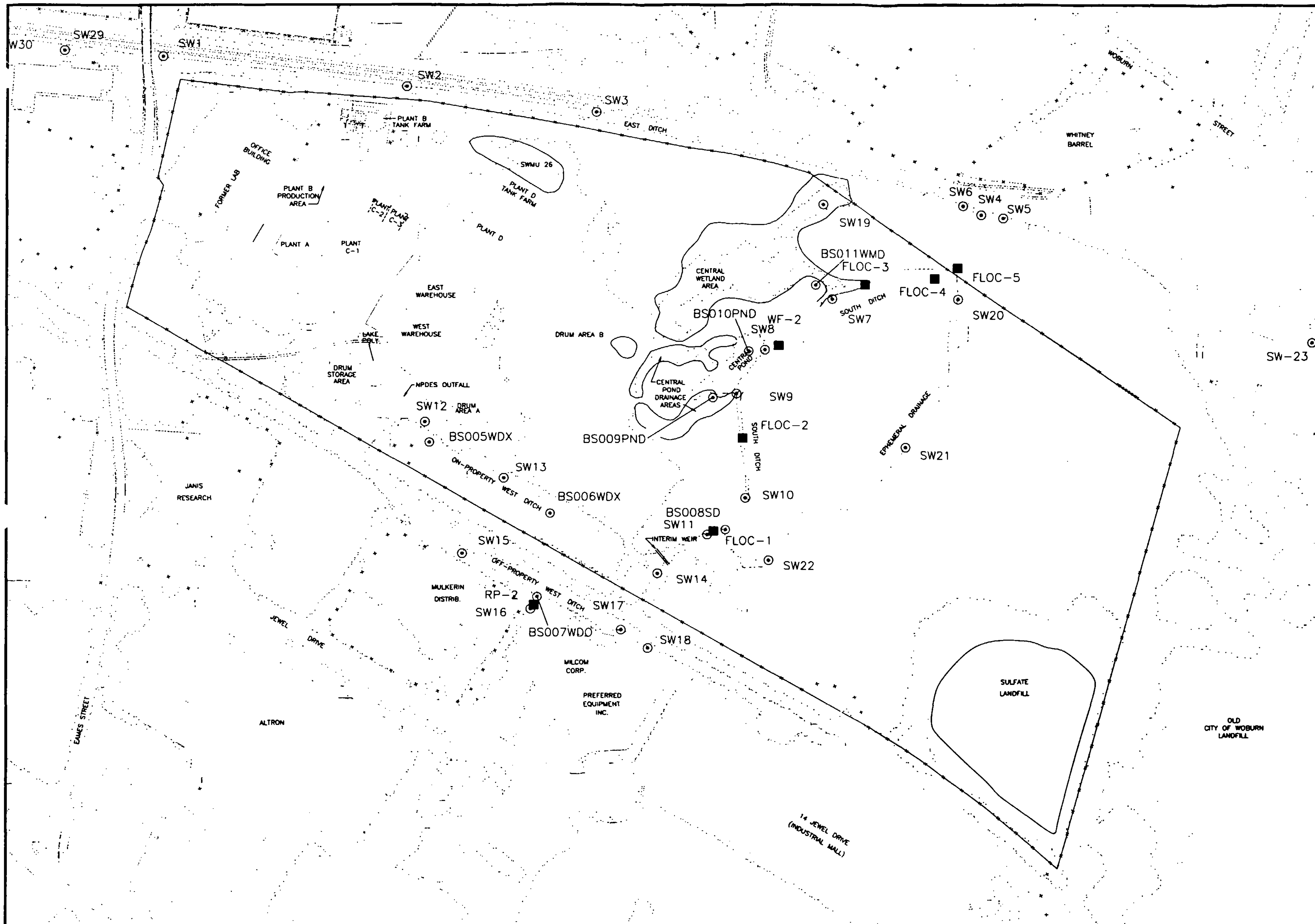
REGISTERED

OLIN CORPORATION
Wilmington, Massachusetts

FIGURE 7
SURFACE WATER SAMPLE LOCATIONS

SCALE	
PROJECT NO.	
FIG.SWTITLE	
SHEET	

Drawing 7074-035
Xrefs OLIN-WETLDWG



LEGEND

(heavy line)	PROPERTY BOUNDARY
(tree symbols)	TREES AND TREELINES
(thin line)	WATER BODIES
(box with marsh symbols)	WETLANDS LINE
PLANT A	DENOTES FORMER FEATURES (CSA, CRA 1993)
⊙	SEDIMENT SAMPLING LOCATIONS
■	FLOC SAMPLING LOCATIONS

SW-24, SW-25 AND SW-26 LOCATED 800 FEET DOWNSTREAM.
SW-27 LOCATED 2,300 FEET DOWNSTREAM.
SW-28 LOCATED 4,900 FEET DOWNSTREAM.

NO.	REVISIONS	DATE	ENGR.	DATE	ISSUED FOR

SMITH — SMITH TECHNOLOGY CORPORATION

PROJECT HYDROGEOLOGIST	APPROVED
DRAWN BY	
PROJECT GEOLOGIST	APPROVED
PROJECT MGR.	
CHECKED BY	DATE

SEAL

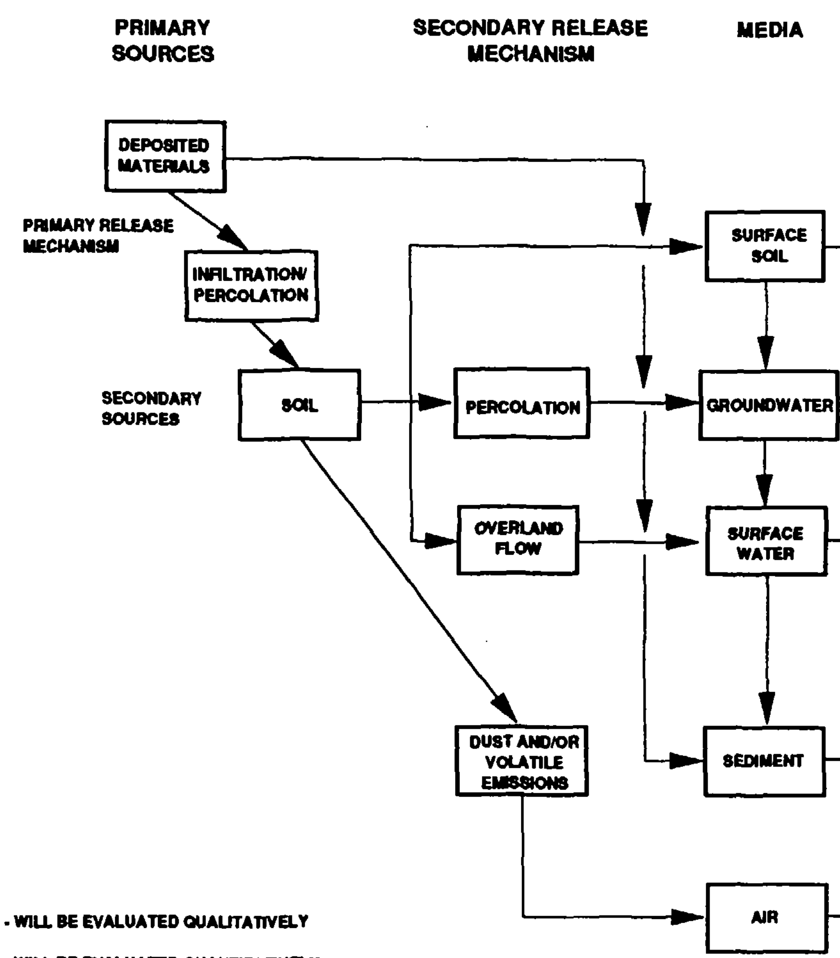
REGISTERED

OLIN CORPORATION
Wilmington, Massachusetts

FIGURE 8
SEDIMENT SAMPLE LOCATIONS

SCALE	
PROJECT NO.	
	OSEDLOC
SHEET	

Drawing: 7074-025
Xrefs: OLIN-NEWDN



MEDIA	EXPOSURE ROUTE	WILDLIFE	AQUATIC LIFE	PLANTS	AMPHIBIANS	TERRESTRIAL INVERTEBR.
SURFACE SOIL	SOIL INGESTION	●				●
	DIRECT CONTACT	■		■		●
	INGESTION OF FOOD	●				
SURFACE WATER	WATER INGESTION	●	■		●	
	DIRECT CONTACT	■	■	■	●	
	INGESTION OF FOOD	●	▲		▲	
SEDIMENT	DIRECT CONTACT	■	■	▲	●	
	INGESTION OF FOOD	●	▲		▲	
	SEDIMENT INGESTION	●	▲		▲	
AIR	INHALATION					

■ - WILL BE EVALUATED QUALITATIVELY

● - WILL BE EVALUATED QUANTITATIVELY

▲ - EXPOSURES POSSIBLE BUT LACK OF APPROPRIATE EXPOSURE AND TOXICITY INFORMATION MAY LIMIT OR PREVENT EVALUATION

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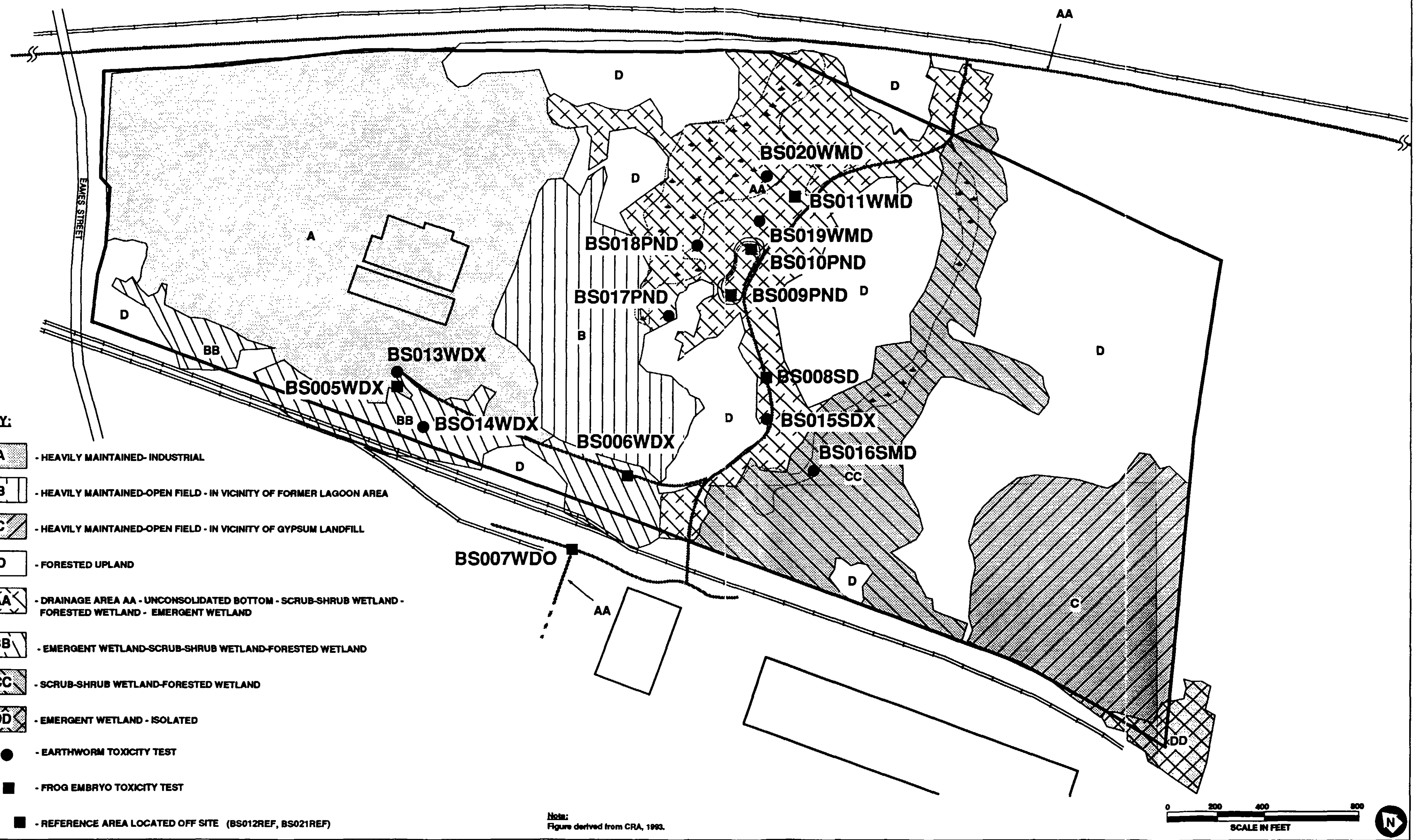
ASEA BROWN BOVERI

FIGURE 9
CONTAMINANT PATHWAY MODEL
OLIN CORPORATION - WILMINGTON PROPERTY
WILMINGTON, MA

7331-07



KEY:

A	- HEAVILY MAINTAINED- INDUSTRIAL
B	- HEAVILY MAINTAINED-OPEN FIELD - IN VICINITY OF FORMER LAGOON AREA
C	- HEAVILY MAINTAINED-OPEN FIELD - IN VICINITY OF GYPSUM LANDFILL
D	- FORESTED UPLAND
AA	- DRAINAGE AREA AA - UNCONSOLIDATED BOTTOM - SCRUB-SHRUB WETLAND - FORESTED WETLAND - EMERGENT WETLAND
BB	- EMERGENT WETLAND-SCRUB-SHRUB WETLAND-FORESTED WETLAND
CC	- SCRUB-SHRUB WETLAND-FORESTED WETLAND
DD	- EMERGENT WETLAND - ISOLATED
●	- EARTHWORM TOXICITY TEST
■	- FROG EMBRYO TOXICITY TEST
● ■	- REFERENCE AREA LOCATED OFF SITE (BS012REF, BS021REF)

Note:
Figure derived from CRA, 1993.

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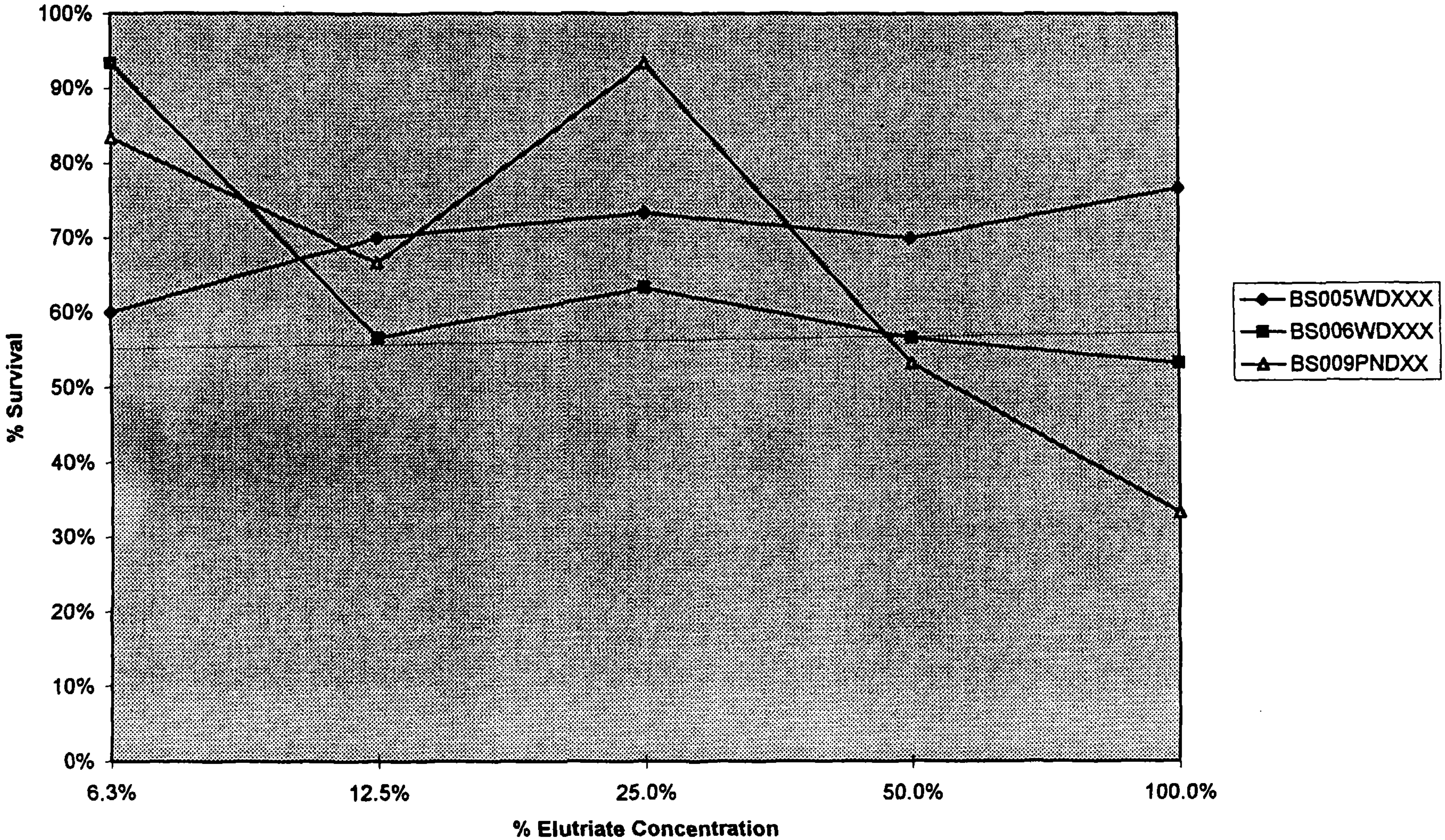
FIGURE 10
TOXICITY TEST LOCATION MAP
OLIN CORPORATION - WILMINGTON PROPERTY
WILMINGTON, MA

FI. RE 11
FETAX DEFINITIVE ASSAY RESULTS -
PERCENT SURVIVAL VERSUS PERCENT ELUTRIATE CONCENTRATION

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS



ATTACHMENT #1

BIOLOGICAL SAMPLING

Biological Sampling

1.0 Methods

ABB-ES ecologists conducted a biological sampling program at the Facility during the period of 9-11 October 1996. The purpose of the biological sampling was to gather site-specific data regarding levels of site-related constituents in biota. These data were used, along with data from other environmental media, to estimate the dietary exposures for the selected wildlife receptor species at the Facility.

The biological sampling program focused on the collection of the following types of terrestrial and aquatic biota: small mammals, plants, macroinvertebrates (crayfish), and amphibians (mature frogs and tadpoles). Field data collected on the small mammals included genus and species, sex, age class, weight, body length, tail length, and hind foot length. For invertebrates and amphibians the number of individuals captured at each sample location was noted, crayfish were categorized into the small, medium, and large size groups, and individual frogs and composites of tadpoles were identified to genus and species and weighed. Plants were identified to genus and to species if possible. Chemical analysis was conducted on the small mammals, invertebrates, amphibians, and plants and included TCL pesticides, TAL inorganics and percent lipid; selected mammal, invertebrate, and amphibian samples were also analyzed for TCL SVOCs.

2.0 Species Collected

A variety of species were sampled in order to evaluate the SVOC, pesticide, and inorganic tissue concentrations throughout the food chain. Fifteen small mammal samples, four plant samples, nine crayfish samples, and seven amphibian samples were collected from the Facility and submitted for chemical analysis. A summary of the biota sampled and the chemical analysis requested for each sample is presented in Table 1. Approximate snap trap and minnow trap locations are presented in Figures A1-1 and A1-2. Individual trap locations were not permanently marked in the field. The following sections describe the methods and results of the biological sampling event.

2.2.1 Small Mammals

Small mammals were collected using snap traps, which were grouped in six areas within the Facility. These areas included the west ditch (WD), west ditch off-site (WDO), south ditch (STD), pond (PND), wet meadow (WMD), and terrestrial area (TER). The west ditch included the emergent marsh at the top of the channelized west ditch to the south ditch. The west ditch off-site included all of the fenced in portion of the ditch, south to the gabion wall. The south ditch included the area beginning at the confluence of the west ditch and followed along the south ditch to the pond, the wet meadow located to the south of the ditch was also considered part of the south ditch system for the biological sampling. The pond area included the wetland and terrestrial areas immediately bordering the pond. The wet meadow area included the wetland area to the east northeast of the pond which consisted of scrub/shrub and emergent wetlands. This area is hydrologically connected to the south ditch east of the pond. The terrestrial area consisted of the forested area northeast of the pond; this area does include some small wetland habitats. No small mammals were collected from the reference area.

West Ditch and West Ditch Off-site

A total of 21 snap traps were set in the West Ditch and West Ditch Off-site on 9 October 1996. On 10 October 1996 these traps yielded six small mammals (all white-footed mice [*Peromyscus leucopus*]); four from the west ditch and two from the west ditch off-site. The four small mammals collected from the west ditch were composited into two samples (SM001WDXX and SM002WDXX) to provide enough sample quantity to conduct the full analytical suite (i.e. TCL SVOCs, TCL pesticides, TAL inorganics, and percent lipids). The two small mammals collected from the west ditch off-site were each analyzed as separate samples (SM003WDOX and SM004WDOX). The analysis on these samples included TCL pesticides, TAL inorganics, and percent lipids. The traps in this area were not reset, as it was determined in the field that enough sample quantity had been collected to conduct the chemical analysis.

South Ditch

A total of 15 snap traps were set along the south ditch and south ditch wet meadow area on 9 October 1996 and checked the following day. No small mammals were trapped along the south ditch, however the traps in the wet meadow area yielded one white-footed mouse (*P. leucopus*). Due to the limited number of small mammals trapped in the south ditch area, an additional 21 traps were set on 10 October 1996 to increase trap success in this area. Traps were placed randomly around the wet meadow area and in two transects along the north side of the south ditch. On 11 October 1996 these traps were sampled and yielded four additional small mammals including three white-footed mice (*P. leucopus*) and one meadow vole (*Microtus pennsylvanicus*). The white-footed mouse samples collected on 11 October 1996, along with the sample collected the previous day, were composited into two samples (SM005STDXX and SM006STDXX). The meadow vole was analyzed as a separate sample (SM007STDXX). Sample SM005STDXX was analyzed for the full analytical suite.

Pond

A total of 20 snap traps were set around the western and northern perimeter of the pond, and in the forested area north and west of the pond on 9 October 1996 and checked the following day. A total of three white-footed mice (*P. leucopus*) were collected from traps located around the perimeter of the pond, although none of the traps set to the north and west of the pond yielded any small mammals. On 10 October 1996, an additional five traps were set along the southern perimeter of the pond, between the pond and the south ditch. The following day these traps were checked but they yielded no additional small mammals. The white-footed mouse samples collected on 10 October 1996 were composited into one sample (SM012PNDXX), and analyzed for the full analytical suite.

Wet Meadow

A total of eight snap traps were set in the wet meadow northeast of the pond on 9 October 1996 and checked the next day; they yielded a total of two white-footed mice (*P. leucopus*). On 10 October 1996, an additional five traps were set in this area. The following day traps were checked and three additional white-footed mice (*P. leucopus*) and one short-tailed shrew (*Blarina brevicauda*) were collected. The mice collected on 10 October 1996 were composited into one sample (SM008WMDXX) and analyzed for the full analytical suite. For the small mammals collected on 11 October 1996, the shrew was analyzed as a separate sample (SM009WMDXX), as was the larger of the three mice (SM010WMDXX). The remaining two mice were composited (SM011WMDXX) to make a total of four samples from the wet meadow. The three samples (one shrew and two mice samples) collected on 11 October 1996, were analyzed for TCL pesticides, TAL inorganics, and percent lipids.

Terrestrial Area

On 10 October 1996, an 20 additional traps were set in two parallel transects in the forested area to the north and west of the pond. These traps were checked the following day and yielded six small mammals including two short-tailed shrews (*B. brevicauda*) and four white-footed mice (*P. leucopus*). The shrews were composited into one sample (SM013TERXX), and analyzed for TCL pesticides, TAL inorganics, and percent lipids. The four mice were composited into two samples (SM014TERXX and SM015TERXX), one of which was analyzed for the full analytical suite and the other was analyzed just TCL pesticides, TAL inorganics, and percent lipids.

2.2.2 Plants

Herbaceous plants were collected from four locations within two semi-aquatic habitats at the Facility. Plant sample locations are shown on Figure A1-1. Two types of herbaceous vegetation were selected in the field and sampled, a persistent emergent (cattail, *Typha latifolia*) and two sedges (sedge, *Carex sp.* and wool grass, *Scirpus cyperinus*). These species were selected based on the time of year, availability, and value as a food source for birds and small mammals. The first two plant samples were collected from two locations within the emergent marsh at the head of the west ditch. These samples (PL001WDXX and PLOO2WDXX) included the tubers of a small group of cattails (*Typha latifolia*); individual plant sampling was impossible due to the rhizomal growth patterns of this plant. The remaining two plant samples were collected from the wet meadow northeast of the pond. The third plant sample (PL003WMDXX) consisted of the above ground, edible portion of a group of sedges (*Carex* sp.). The fourth sample (PL004WMDXX) consisted of the above ground portion of an individual wool grass (*Scirpus cyperinus*) plant. No plant samples were collected from the reference area. A sediment sample, consisting of two 250 ml amber jars, was collected from the immediate vicinity of the each of the plant samples. Both the plant and sediment samples collected at each of these locations were analyzed for TCL pesticides and TAL inorganics.

2.2.3 Aquatic Species

Aquatic species were sampled using minnow traps baited with canned cat food. Traps were placed in four distinct areas within the facility and at the reference location. These areas included the west ditch (WD), west ditch off-site (WDO), south ditch (SD), and the pond (PND). In the south ditch, minnow traps were set at the confluence of the west ditch, behind the weir, and along the a reach of the south ditch adjacent to the pond. An electroshocking unit and dip net was also employed in the collection of aquatic species in the pond and ditch systems at the Facility. The two primary aquatic species collected at the Facility were crayfish (*Procambarus sp.*) and northern leopard frogs and tadpoles (*Rana pipiens*).

Macroinvertebrates (Crayfish)

Crayfish (*Procambarus sp.*) were most prevalent in the west ditch, west ditch off-site, south ditch, and the reference stream. A total of nine minnow traps were placed in the west ditch and west ditch off-site on 9 October 1996 (Figure A1-2) . Four minnow traps in the upper emergent marsh section of the west ditch were unproductive throughout the biological sampling program.

Three crayfish samples (CF001WDXXD,CF001WDXX, CF002WDXX) were collected from the bottom of the west ditch near the confluence of the south ditch. Each of the minnow traps from this area contained enough biomass to make-up three individual composite samples. The two traps placed in the west ditch off-site each contained enough biomass to composite into individual samples (CF003WDXX and CF004WDXX). Two of the samples collected from the west ditch (CF001WDXXD and CF001WDXX) and one from the west ditch off-site (CF003WDXX) were analyzed for the full analytical suite, while the other samples were analyzed for TCL pesticides, TAL inorganics, and percent lipids.

A total of nine minnow traps were placed in two distinct areas of the south ditch, behind the weir and along the reach of the south ditch in the vicinity of the pond (Figure A1-2). The reach of the south ditch between the weir and the pond did not, at the time of the biological sampling contain enough water to use minnow traps. Three minnow traps were placed behind the weir on the west end of the south ditch; enough biomass was collected in one trap to composite into a sample (CF005STDXX). The remaining three samples (CF006STDXX, CF007STDXX, and CF008STDXX) were collected from traps located along the reach of the south ditch next to the pond. Two of the samples collected from the south ditch (CF006STDXX and CF007STDXX) were analyzed for the full analytical suite, while the other samples (CF008STDXX and CF005STDXX) were analyzed for TCL pesticides, TAL inorganics, and percent lipids.

One additional crayfish sample (CF009REFXX) was collected from the reference location. This sample consisted of one individual crayfish, and was analyzed for TCL pesticides and percent lipids only.

Amphibians (Frogs)

Frogs collected at the Facility included both adults and juveniles (tadpoles). Adult frogs were collected using an electroshocking unit and a dip net. Tadpoles were collected in minnow traps. All of the tadpole samples were collected from the pond. Adult frogs were collected from the west ditch, south ditch, and pond area. Figure 2 presents the frog sample locations. Three of the four samples collected in the pond consisted of composited tadpoles. Each of these three samples (FR001PNDXX, FR005PNDXX, and FR006PNDXX) were analyzed for the full analytical suite. A single adult frog (*Rana pipiens*) sample was collected from the pond (FR002PNDXX), and analyzed for TAL pesticides, TCL inorganics, and percent lipids.

Additional frog samples were collected from the south ditch area, west ditch emergent marsh, and west ditch channelized area. Sample FR003STDXX was comprised of a single adult frog collected in the wet meadow area, south of the south ditch. Chemical analysis of this sample included TAL pesticides, TCL inorganics, and percent lipids. Three adult frogs were collected from the channelized portion of the west ditch, and composited. This sample (FR004WDXX) was analyzed for TAL pesticides, TCL inorganics, and percent lipids. The last frog sample (FR007WDXX) consisted of a single adult frog collected in the emergent marsh portion of the west ditch; chemical analysis included the full analytical suite. No amphibian samples were collected from the reference area.

2.3 Sample Handling and Preparation

All of the biological samples were wrapped in aluminum foil, placed in labeled plastic bags, and stored in coolers packed with dry ice in the field. The plant samples, their paired sediment samples, and rinsate blank were packed in coolers with ice and shipped to the analytical laboratory on 11 October 1996. Small mammal, macroinvertebrate, and amphibian samples were placed in a locked freezer at the ABB-ES office in Wakefield, Massachusetts at the end of each of each sampling day. On 15 October 1996, the samples collected over the three day sampling event were composited, packed on dry ice, and shipped to the analytical laboratory frozen.

The analytical laboratory processed the biological samples following standard laboratory protocols. The chemical analysis was conducted as whole body (i.e. the whole sample was homonogized, and if a sample was a composite, all of the individuals included in the composite were processed).

2.4 Analytical Results

A summary of the SVOCs, pesticides, and inorganics detected in small mammals is presented in TableA1-1. A summary of the SVOCs, pesticides, and inorganics detected in plants, macroinvertebrates, and amphibians are presented in Tables A1-2, A1-3, and A1-4, respectively. In addition to the biological samples collected in the field, analytical results were also obtained for earthworms used in toxicity tests (Table A1-5).

2.4.1 Small Mammals

Five of the fifteen small mammal samples collected were analyzed for SVOCs; bis(2-Ethylhexyl)phthalate was detected in all five samples, at concentrations that ranged from 1000 ug/kg to 12,000 ug/kg. Phenol was detected in one sample, at 260 ug/kg. Seven pesticides (4,4'-DDE, 4,4'-DDT, dieldrin, endosulfan sulfate, endrin, endrin aldehyde, and heptachlor epoxide) were detected in small mammals. The majority of maximum detected concentrations were from sample locations within the terrestrial area northwest of the Central Pond (sample SM013TER and SM015TER). A total of eighteen TAL inorganic analytes, excluding the essential nutrients (calcium, iron, magnesium, potassium, and sodium), were detected in small mammals. The majority of maximum detected concentrations of inorganic analytes were from sample SM009WMD.

2.4.2 Plants

Chemical analysis of plants did not include SVOCs. Five pesticides (alpha-BHC, alpha-chlordane, delta-BHC, gamma-BHC, and heptachlor) were detected in plant samples. The majority of maximum detected concentrations were in sample PL003WMDXX located in the wet meadow north of South Ditch. Concentrations detected in plants ranged from 0.901 to 2.86 ug/kg (alpha-BHC and delta-BHC, respectively). Fourteen TAL inorganic analytes, excluding the essential nutrients (calcium, iron, magnesium, potassium, and sodium), were detected in plants. Antimony, arsenic, beryllium, and silver were analyzed for, but not detected.

2.4.3 Crayfish

Four of the ten crayfish samples collected were analyzed for SVOCs; bis(2-Ethylhexyl)phthalate was detected at the following concentrations: 890 ug/kg, 3000 ug/kg, and 5900 ug/kg at sample locations CF006STD, CF007STD, and CF001WDX, respectively. The only pesticide detected in macroinvertebrates was 4,4'-DDT at a concentration of 8.28 ug/kg, which was collected from the reference area (sample CF009REF). Fifteen TAL inorganic analytes, excluding the essential nutrients (calcium, iron, magnesium, potassium, and sodium), were detected in macroinvertebrates. Antimony, beryllium, and thallium were analyzed for, but not detected.

2.4.4 Amphibians

Four of the seven amphibian samples collected were analyzed for SVOCs; bis(2-Ethylhexyl)phthalate was detected at concentrations that ranged from 220 ug/kg to 23,000 ug/kg. The maximum detected concentration was in sample FR006PND. Fourteen pesticides were detected in amphibian samples. The majority of the maximum detected concentrations were in sample FR001PND. Seventeen TAL inorganic analytes, excluding the essential nutrients (calcium, iron, magnesium, potassium, and sodium), were detected in amphibians. Thallium was the only inorganic analyte analyzed for, but not detected.

2.4.5 Earthworms

Earthworm tissue data were obtained from laboratory-reared earthworms exposed to site soils in the bioaccumulation study. Seven SVOCs were detected in earthworms, including 2- and 4-methylphenol, N-nitrosodiphenylamine, di-n-butylphthalate, and bis(2-Ethylhexyl)phthalate. SVOCs were detected at maximum concentrations that ranged from 17 ug/kg (4-methylphenol) to 2100 ug/kg (bis(2-Ethylhexyl)phthalate). The maximum detected concentrations of N-nitrosodiphenylamine, di-n-butylphthalate, and bis(2-Ethylhexyl)phthalate were detected in sample BS018PNDX. Eight pesticides were detected in earthworms, including alpha-, beta-, delta-, and gamma-BHC, dieldrin, 4,4'-DDD, 4,4'-DDE, and 4,4'-DDT. Pesticides were detected at maximum concentrations that ranged from 0.92 ug/kg (dieldrin) to 11 ug/kg (4,4'-DDT). The majority of maximum concentrations were detected in BS018PNDX. Nineteen metals were detected in earthworms. The only analytes that were not detected in earthworms were antimony, beryllium, silver, and thallium. Metals were detected at maximum concentrations that ranged from 0.88 mg/kg (nickel) to 841 mg/kg (aluminum). The majority of maximum detected concentrations were from sample location BS013WDXX.

2.4.6 Results of Sediment Analyses

Results of the sediment samples collected during the biological sampling program have been included with the previously collected sediment data and are included in that discussion as well.

TABLE A1-1
SMALL MAMMAL ANALYTICAL DATA USED IN THE ENVIRONMENTAL RISK CHARACTERIZATION

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

	LOCATION							
	SM001WDX	SM002WDX	SM003WDO	SM004WDO	SM005STD	SM006STD	SM007STD	SM008WMD
SVOCs (mg/kg)								
1,2,4-Trichlorobenzene	NA	0.19 U	NA	NA	NA	0.77 U	NA	0.8 U
1,3-Dichlorobenzene	NA	0.19 U	NA	NA	NA	0.77 U	NA	0.8 U
1,2-Dichlorobenzene	NA	0.19 U	NA	NA	NA	0.77 U	NA	0.8 U
1,4-Dichlorobenzene	NA	0.19 U	NA	NA	NA	0.77 U	NA	0.8 U
2,2'-oxybis(1-Chloropropane)	NA	0.19 U	NA	NA	NA	0.77 U	NA	0.8 U
2,3,6-Trichlorophenol	NA	0.19 U	NA	NA	NA	0.77 U	NA	0.8 U
2,4,5-Trichlorophenol	NA	0.19 U	NA	NA	NA	0.77 U	NA	0.8 U
2,4,6-Trichlorophenol	NA	0.19 U	NA	NA	NA	0.77 U	NA	0.8 U
2,4-Dichlorophenol	NA	0.19 U	NA	NA	NA	0.77 U	NA	0.8 U
2,4-Dimethylphenol	NA	0.19 U	NA	NA	NA	0.77 U	NA	0.8 U
2,4-Dinitrophenol	NA	0.94 U	NA	NA	NA	3.8 U	NA	4 U
2,4-Dinitrotoluene	NA	0.19 U	NA	NA	NA	0.77 U	NA	0.8 U
2,6-Dinitrotoluene	NA	0.19 U	NA	NA	NA	0.77 U	NA	0.8 U
2-Chloronaphthalene	NA	0.19 U	NA	NA	NA	0.77 U	NA	0.8 U
2-Chlorophenol	NA	0.19 U	NA	NA	NA	0.77 U	NA	0.8 U
2-Nitrophenol	NA	0.19 U	NA	NA	NA	0.77 U	NA	0.8 U
3,3'-Dichlorobenzidine	NA	0.19 U	NA	NA	NA	0.77 U	NA	0.8 U
4,6-Dinitro2methylphenol	NA	0.19 U	NA	NA	NA	0.77 U	NA	0.8 U
4-Bromophenyl-phenylether	NA	0.19 U	NA	NA	NA	0.77 U	NA	0.8 U
4-Chloro-3-Methylphenol	NA	0.19 U	NA	NA	NA	0.77 U	NA	0.8 U
4-Chlorophenylphenylether	NA	0.19 U	NA	NA	NA	0.77 U	NA	0.8 U
4-Nitrophenol	NA	0.94 U	NA	NA	NA	3.8 U	NA	4 U
Acenaphthene	NA	0.19 U	NA	NA	NA	0.77 U	NA	0.8 U
Acenaphthylene	NA	0.19 U	NA	NA	NA	0.77 U	NA	0.8 U
Anthracene	NA	0.19 U	NA	NA	NA	0.77 U	NA	0.8 U
Azobenzene	NA	0.19 U	NA	NA	NA	0.77 U	NA	0.8 U
Benzidine	NA	0.19 U	NA	NA	NA	0.77 U	NA	0.8 U
Benzo(a)anthracene	NA	0.19 U	NA	NA	NA	0.77 U	NA	0.8 U
Benzo(a)pyrene	NA	0.19 U	NA	NA	NA	0.77 U	NA	0.8 U
Benzo(b)fluoranthene	NA	0.19 U	NA	NA	NA	0.77 U	NA	0.8 U
Benzo(g,h,i)perylene	NA	0.19 U	NA	NA	NA	0.77 U	NA	0.8 U
Benzo(k)fluoranthene	NA	0.19 U	NA	NA	NA	0.77 U	NA	0.8 U
Biphenyl	NA	0.19 U	NA	NA	NA	0.77 U	NA	0.8 U

TABLE A1-1
SMALL MAMMAL ANALYTICAL DATA USED IN THE ENVIRONMENTAL RISK CHARACTERIZATION

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

	LOCATION							
	SM001WDX	SM002WDX	SM003WDO	SM004WDO	SM005STD	SM006STD	SM007STD	SM008WMD
SVOCs (mg/kg) cont.								
bis(2-Chloroethyl)Ether	NA	0.19 U	NA	NA	NA	0.77 U	NA	0.8 U
bis(2Ethylhexyl)phthalate	NA	1	NA	NA	NA	12	NA	1.6
Butylbenzylphthalate	NA	0.19 U	NA	NA	NA	0.77 U	NA	0.8 U
Carbazole	NA	0.19 U	NA	NA	NA	0.77 U	NA	0.8 U
Chrysene	NA	0.19 U	NA	NA	NA	0.77 U	NA	0.8 U
Di-n-butylphthalate	NA	0.19 U	NA	NA	NA	0.77 U	NA	0.8 U
Di-n-octylphthalate	NA	0.19 U	NA	NA	NA	0.77 U	NA	0.8 U
Dibenz(a,h)anthracene	NA	0.19 U	NA	NA	NA	0.77 U	NA	0.8 U
Dibenzofuran	NA	0.19 U	NA	NA	NA	0.77 U	NA	0.8 U
Dibenzothiophene	NA	0.19 U	NA	NA	NA	0.77 U	NA	0.8 U
Diethylphthalate	NA	0.19 U	NA	NA	NA	0.77 U	NA	0.8 U
Dimethylphthalate	NA	0.19 U	NA	NA	NA	0.77 U	NA	0.8 U
Fluoranthene	NA	0.19 U	NA	NA	NA	0.77 U	NA	0.8 U
Fluorene	NA	0.19 U	NA	NA	NA	0.77 U	NA	0.8 U
Hexachlorobenzene	NA	0.19 U	NA	NA	NA	0.77 U	NA	0.8 U
Hexachlorobutadiene	NA	0.19 U	NA	NA	NA	0.77 U	NA	0.8 U
Hexachlorocyclopentadiene	NA	0.94 U	NA	NA	NA	3.8 U	NA	4 U
Hexachloroethane	NA	0.19 U	NA	NA	NA	0.77 U	NA	0.8 U
Indeno(1,2,3-cd)pyrene	NA	0.19 U	NA	NA	NA	0.77 U	NA	0.8 U
Isophorone	NA	0.19 U	NA	NA	NA	0.77 U	NA	0.8 U
N-Nitrosodimethylamine	NA	0.19 U	NA	NA	NA	0.77 U	NA	0.8 U
N-Nitrosodinpropylamine	NA	0.19 U	NA	NA	NA	0.77 U	NA	0.8 U
Naphthalene	NA	0.19 U	NA	NA	NA	0.77 U	NA	0.8 U
N-Nitrosodiphenylamine	NA	0.19 U	NA	NA	NA	0.77 U	NA	0.8 U
Nitrobenzene	NA	0.19 U	NA	NA	NA	0.77 U	NA	0.8 U
Phenanthrene	NA	0.19 U	NA	NA	NA	0.77 U	NA	0.8 U
Pentachlorophenol	NA	0.94 U	NA	NA	NA	3.8 U	NA	4 U
Phenol	NA	0.26	NA	NA	NA	0.77 U	NA	0.8 U
Pyrene	NA	0.19 U	NA	NA	NA	0.77 U	NA	0.8 U

TABLE A1-1
SMALL MAMMAL ANALYTICAL DATA USED IN THE ENVIRONMENTAL RISK CHARACTERIZATION

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

	LOCATION							
	SM001WDX	SM002WDX	SM003WDO	SM004WDO	SM005STD	SM006STD	SM007STD	SM008WMD
PESTICIDES (mg/kg)								
4,4'-DDD	0.0033 U	0.0032 U	0.0033 U	0.0037 U	0.0029 U	0.0033 U	0.003 U	0.003 U
4,4'-DDE	0.0033 U	0.0032 U	0.0033 U	0.0037 U	0.0029 U	0.0033 U	0.003 U	0.003 U
4,4'-DDT	0.0033 U	0.0032 U	0.0033 U	0.0037 U	0.0029 U	0.0033 U	0.003 U	0.003 U
Aldrin	0.0017 U	0.0016 U	0.0017 U	0.0019 U	0.0015 U	0.0017 U	0.0016 U	0.0015 U
alpha-BHC	0.0017 U	0.0016 U	0.0017 U	0.0019 U	0.0015 U	0.0017 U	0.0016 U	0.0015 U
alpha-Chlordane	0.0017 U	0.0016 U	0.0017 U	0.0019 U	0.0015 U	0.0017 U	0.0016 U	0.0015 U
beta-BHC	0.0017 U	0.0016 U	0.0017 U	0.0019 U	0.0015 U	0.0017 U	0.0016 U	0.0015 U
delta-BHC	0.0017 U	0.0016 U	0.0017 U	0.0019 U	0.0015 U	0.0017 U	0.0016 U	0.0015 U
Dieldrin	0.0033 U	0.0032 U	0.0033 U	0.0037 U	0.0029 U	0.0033 U	0.003 U	0.003 U
Endosulfan I	0.0017 U	0.0016 U	0.0017 U	0.0019 U	0.0015 U	0.0017 U	0.0016 U	0.0015 U
Endosulfan sulfate	0.0033 U	0.0032 U	0.0033 U	0.0037 U	0.0029 U	0.0033 U	0.003 U	0.003 U
Endosulfan II	0.0033 U	0.0032 U	0.0033 U	0.0037 U	0.0029 U	0.0033 U	0.003 U	0.003 U
Endrin	0.0033 U	0.0032 U	0.0033 U	0.0037 U	0.0029 U	0.0033 U	0.003 U	0.003 U
Endrin ketone	0.0033 U	0.0032 U	0.0033 U	0.0037 U	0.0029 U	0.0033 U	0.003 U	0.003 U
Endrin aldehyde	0.0033 U	0.0032 U	0.0033 U	0.0037 U	0.0019 JP	0.0033 U	0.003 U	0.003 U
gamma-BHC (Lindane)	0.0017 U	0.0016 U	0.0017 U	0.0019 U	0.0015 U	0.0017 U	0.0016 U	0.0015 U
gamma-Chlordane	0.0017 U	0.0016 U	0.0017 U	0.0019 U	0.0015 U	0.0017 U	0.0016 U	0.0015 U
Heptachlor	0.0017 U	0.0016 U	0.0017 U	0.0019 U	0.0015 U	0.0017 U	0.0016 U	0.0015 U
Heptachlor Epoxide	0.0017 U	0.0016 U	0.0017 U	0.0019 U	0.0086	0.0017 U	0.0016 U	0.0015 U
Methoxychlor	0.017 U	0.016 U	0.017 U	0.019 U	0.015 U	0.017 U	0.016 U	0.015 U
Toxaphene	0.17 U	0.16 U	0.17 U	0.19 U	0.15 U	0.17 U	0.16 U	0.15 U

TABLE A1-1
SMALL MAMMAL ANALYTICAL DATA USED IN THE ENVIRONMENTAL RISK CHARACTERIZATION

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

	LOCATION							
	SM001WDX	SM002WDX	SM003WDO	SM004WDO	SM005STD	SM006STD	SM007STD	SM008WMD
METALS (mg/kg)								
ALUMINUM	7.7224	7.7783 B	5.4433 B	3.7459 B	2.034 B	1.8201 B	9.751	4.1189 B
ANTIMONY	0.0946 U	0.1478 U	0.152 B	0.1288 U	0.3126 B	0.1753 B	0.1167 U	0.123 U
ARSENIC	0.1388 U	0.2167 U	0.2167 U	0.1888 U	0.2075 U	0.2009 U	0.1712 U	0.1803 U
BARIUM	0.7539 B	1.9931 B	1.5818 B	3.4416 B	2.1057 B	1.6493 B	2.0696 B	1.6967 B
BERYLLIUM	0.0063 U	0.0099 U	0.0099 U	0.0086 U	0.0094 U	0.0091 U	0.0078 U	0.0082 U
CADMIUM	0.0457 B	0.1129 B	0.0296 U	0.0258 U	0.0341 B	0.0385 B	0.0233 U	0.0246 U
CALCIUM	4791.798	6359.606	6512.315	14489.27	6372.642	8319.635	5766.537	14180.33
CHROMIUM TOTAL	0.5338	0.3452 B	0.2608 B	0.4091 B	0.4636 B	0.5023	1.3362	0.4184
COBALT	0.0578 B	0.0984 B	0.064 U	0.0558 U	0.0613 U	0.0594 U	0.0742 B	0.0566 B
COPPER	3.3407	3.7956	2.9266	3.0133	3.0226	2.8251	3.7829	3.1504
IRON	83.0599	79.5074	61.33	77.4678	60.0472	52.6027	61.5175	64.2623
LEAD	0.1515	0.2232	0.1133 U	0.1005 B	0.1085 U	0.2037	0.1104 B	0.1851
MAGNESIUM	375.7098	515.2709	370.4926	510.7296	330.3774	376.3927	332.9183	511.8852
MANGANESE	6.0221	13.9803	5.0099	4.2296	6.5849	8.6256	13.6537	11.2828
MERCURY	0.0059 U	0.0068 U	0.01 U	0.0034 U	0.0075 U	0.0093 U	0.0093 U	0.0063 U
NICKEL	0.4309 B	0.4675 B	0.3015 B	0.3205 B	0.1641 B	0.2804 B	0.577 B	0.3881 B
POTASSIUM	2770.978	3261.084	3216.256	3114.592	3154.245	2849.772	2956.031	3021.721
SELENIUM	0.6615	0.6664	0.6563	0.6431	0.437	0.4508	0.4626	0.5862
SILVER	0.0736 B	0.0739 U	0.0739 U	0.0644 U	0.0708 U	0.0685 U	0.0584 U	0.0615 U
SODIUM	1064.984	1424.138	1143.842	1281.974	1268.868	1335.16	1193.385	1361.475
THALLIUM	0.1293 U	0.202 U	0.202 U	0.176 U	0.1934 U	0.1901 B	0.1595 U	0.1808 B
VANADIUM	0.1309 B	0.1383 B	0.2407 B	0.2264 B	0.1443 B	0.0926 B	0.2489 B	0.1781 B
ZINC	25.9464	28.9803	26.2709	31.8326	28.3208	23.7763	20.2101	32.5

TABLE A1-1
SMALL MAMMAL ANALYTICAL DATA USED IN THE ENVIRONMENTAL RISK CHARACTERIZATION

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

	LOCATION						
	SM009WMD	SM010WMD	SM011WMD	SM012PND	SM013TER	SM014TER	SM015TER
SVOCs (mg/kg)							
1,2,4-Trichlorobenzene	NA	NA	NA	0.77 U	NA	NA	0.75 U
1,3-Dichlorobenzene	NA	NA	NA	0.77 U	NA	NA	0.75 U
1,2-Dichlorobenzene	NA	NA	NA	0.77 U	NA	NA	0.75 U
1,4-Dichlorobenzene	NA	NA	NA	0.77 U	NA	NA	0.75 U
2,2'-oxybis(1-Chloropropane)	NA	NA	NA	0.77 U	NA	NA	0.75 U
2,3,6-Trichlorophenol	NA	NA	NA	0.77 U	NA	NA	0.75 U
2,4,5-Trichlorophenol	NA	NA	NA	0.77 U	NA	NA	0.75 U
2,4,6-Trichlorophenol	NA	NA	NA	0.77 U	NA	NA	0.75 U
2,4-Dichlorophenol	NA	NA	NA	0.77 U	NA	NA	0.75 U
2,4-Dimethylphenol	NA	NA	NA	0.77 U	NA	NA	0.75 U
2,4-Dinitrophenol	NA	NA	NA	3.8 U	NA	NA	3.8 U
2,4-Dinitrotoluene	NA	NA	NA	0.77 U	NA	NA	0.75 U
2,6-Dinitrotoluene	NA	NA	NA	0.77 U	NA	NA	0.75 U
2-Chloronaphthalene	NA	NA	NA	0.77 U	NA	NA	0.75 U
2-Chlorophenol	NA	NA	NA	0.77 U	NA	NA	0.75 U
2-Nitrophenol	NA	NA	NA	0.77 U	NA	NA	0.75 U
3,3'-Dichlorobenzidine	NA	NA	NA	0.77 U	NA	NA	0.75 U
4,6-Dinitro2methylphenol	NA	NA	NA	0.77 U	NA	NA	0.75 U
4-Bromophenyl-phenylether	NA	NA	NA	0.77 U	NA	NA	0.75 U
4-Chloro-3-Methylphenol	NA	NA	NA	0.77 U	NA	NA	0.75 U
4-Chlorophenylphenylether	NA	NA	NA	0.77 U	NA	NA	0.75 U
4-Nitrophenol	NA	NA	NA	3.8 U	NA	NA	3.8 U
Acenaphthene	NA	NA	NA	0.77 U	NA	NA	0.75 U
Acenaphthylene	NA	NA	NA	0.77 U	NA	NA	0.75 U
Anthracene	NA	NA	NA	0.77 U	NA	NA	0.75 U
Azobenzene	NA	NA	NA	0.77 U	NA	NA	0.75 U
Benzidine	NA	NA	NA	0.77 U	NA	NA	0.75 U
Benzo(a)anthracene	NA	NA	NA	0.77 U	NA	NA	0.75 U
Benzo(a)pyrene	NA	NA	NA	0.77 U	NA	NA	0.75 U
Benzo(b)fluoranthene	NA	NA	NA	0.77 U	NA	NA	0.75 U
Benzo(g,h,i)perylene	NA	NA	NA	0.77 U	NA	NA	0.75 U
Benzo(k)fluoranthene	NA	NA	NA	0.77 U	NA	NA	0.75 U
Biphenyl	NA	NA	NA	0.77 U	NA	NA	0.75 U

TABLE A1-1
SMALL MAMMAL ANALYTICAL DATA USED IN THE ENVIRONMENTAL RISK CHARACTERIZATION

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

	LOCATION						
	SM009WMD	SM010WMD	SM011WMD	SM012PND	SM013TER	SM014TER	SM015TER
SVOCs (mg/kg) cont.							
bis(2-Chloroethyl)Ether	NA	NA	NA	0.77 U	NA	NA	0.75 U
bis(2Ethylhexyl)phthalate	NA	NA	NA	3.8	NA	NA	7.1
Butylbenzylphthalate	NA	NA	NA	0.77 U	NA	NA	0.75 U
Carbazole	NA	NA	NA	0.77 U	NA	NA	0.75 U
Chrysene	NA	NA	NA	0.77 U	NA	NA	0.75 U
Di-n-butylphthalate	NA	NA	NA	0.77 U	NA	NA	0.75 U
Di-n-octylphthalate	NA	NA	NA	0.77 U	NA	NA	0.75 U
Dibenz(a,h)anthracene	NA	NA	NA	0.77 U	NA	NA	0.75 U
Dibenzofuran	NA	NA	NA	0.77 U	NA	NA	0.75 U
Dibenzothiophene	NA	NA	NA	0.77 U	NA	NA	0.75 U
Diethylphthalate	NA	NA	NA	0.77 U	NA	NA	0.75 U
Dimethylphthalate	NA	NA	NA	0.77 U	NA	NA	0.75 U
Fluoranthene	NA	NA	NA	0.77 U	NA	NA	0.75 U
Fluorene	NA	NA	NA	0.77 U	NA	NA	0.75 U
Hexachlorobenzene	NA	NA	NA	0.77 U	NA	NA	0.75 U
Hexachlorobutadiene	NA	NA	NA	0.77 U	NA	NA	0.75 U
Hexachlorocyclopentadiene	NA	NA	NA	3.8 U	NA	NA	3.8 U
Hexachloroethane	NA	NA	NA	0.77 U	NA	NA	0.75 U
Indeno(1,2,3-cd)pyrene	NA	NA	NA	0.77 U	NA	NA	0.75 U
Isophorone	NA	NA	NA	0.77 U	NA	NA	0.75 U
N-Nitrosodimethylamine	NA	NA	NA	0.77 U	NA	NA	0.75 U
N-Nitrosodinpropylamine	NA	NA	NA	0.77 U	NA	NA	0.75 U
Naphthalene	NA	NA	NA	0.77 U	NA	NA	0.75 U
N-Nitrosodiphenylamine	NA	NA	NA	0.77 U	NA	NA	0.75 U
Nitrobenzene	NA	NA	NA	0.77 U	NA	NA	0.75 U
Phenanthrene	NA	NA	NA	0.77 U	NA	NA	0.75 U
Pentachlorophenol	NA	NA	NA	3.8 U	NA	NA	3.8 U
Phenol	NA	NA	NA	0.77 U	NA	NA	0.75 U
Pyrene	NA	NA	NA	0.77 U	NA	NA	0.75 U

TABLE A1-1
SMALL MAMMAL ANALYTICAL DATA USED IN THE ENVIRONMENTAL RISK CHARACTERIZATION

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

	LOCATION						
	SM009WMD	SM010WMD	SM011WMD	SM012PND	SM013TER	SM014TER	SM015TER
PESTICIDES (mg/kg)							
4,4'-DDD	0.0028 U	0.0031 U	0.0032 U	0.0032 U	0.0032 U	0.0029 U	0.0029 U
4,4'-DDE	0.0048	0.0031 U	0.0032 U	0.0032 U	0.011	0.0029 U	0.0029 U
4,4'-DDT	0.0015 JP	0.0031 U	0.0032 U	0.0032 U	0.0052	0.0029 U	0.0044 P
Aldrin	0.0015 U	0.0016 U	0.0016 U	0.0017 U	0.0017 U	0.0015 U	0.0015 U
alpha-BHC	0.0015 U	0.0016 U	0.0016 U	0.0017 U	0.0017 U	0.0015 U	0.0015 U
alpha-Chlordane	0.0015 U	0.0016 U	0.0016 U	0.0017 U	0.0017 U	0.0015 U	0.0015 U
beta-BHC	0.0015 U	0.0016 U	0.0016 U	0.0017 U	0.0017 U	0.0015 U	0.0015 U
delta-BHC	0.0015 U	0.0016 U	0.0016 U	0.0017 U	0.0017 U	0.0015 U	0.0015 U
Dieldrin	0.0023 J	0.0031 U	0.0032 U	0.0032 U	0.0029 JP	0.0029 U	0.0029 U
Endosulfan I	0.0015 U	0.0016 U	0.0016 U	0.0017 U	0.0017 U	0.0015 U	0.0015 U
Endosulfan sulfate	0.0062	0.0031 U	0.0032 U	0.0032 U	0.015	0.0029 U	0.0029 U
Endosulfan II	0.0028 U	0.0031 U	0.0032 U	0.0032 U	0.0032 U	0.0029 U	0.0029 U
Endrin	0.0013 JP	0.0031 U	0.0032 U	0.0032 U	0.0018 JP	0.0029 U	0.0038 P
Endrin ketone	0.0028 U	0.0031 U	0.0032 U	0.0032 U	0.0032 U	0.0029 U	0.0029 U
Endrin aldehyde	0.0028 U	0.0031 U	0.0032 U	0.0032 U	0.0032 U	0.0029 U	0.0017 JP
gamma-BHC (Lindane)	0.0015 U	0.0016 U	0.0016 U	0.0017 U	0.0017 U	0.0015 U	0.0015 U
gamma-Chlordane	0.0015 U	0.0016 U	0.0016 U	0.0017 U	0.0017 U	0.0015 U	0.0015 U
Heptachlor	0.0015 U	0.0016 U	0.0016 U	0.0017 U	0.0017 U	0.0015 U	0.0015 U
Heptachlor Epoxide	0.0015 U	0.0016 U	0.0016 U	0.0017 U	0.0017 U	0.0015 U	0.0015 U
Methoxychlor	0.015 U	0.016 U	0.016 U	0.017 U	0.017 U	0.015 U	0.015 U
Toxaphene	0.15 U	0.16 U	0.16 U	0.17 U	0.17 U	0.15 U	0.15 U

TABLE A1-1
SMALL MAMMAL ANALYTICAL DATA USED IN THE ENVIRONMENTAL RISK CHARACTERIZATION

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

	LOCATION						
	SM009WMD	SM010WMD	SM011WMD	SM012PND	SM013TER	SM014TER	SM015TER
METALS (mg/kg)							
ALUMINUM	4.0653 B	1.7524 U	5.0423 B	4.82 B	8.0251 B	6.8213 B	5.4634 B
ANTIMONY	0.3795 B	0.1975 B	0.1953 B	0.2161 B	0.1884 B	0.1915 B	0.1463 U
ARSENIC	0.2394 B	0.2136 U	0.2066 U	0.216 B	0.2333 B	0.2126 U	0.2146 U
BARIUM	2.9045 B	1.2311 B	1.4113 B	0.5032 B	0.8322 B	1.5314 B	2.2551 B
BERYLLIUM	0.009 U	0.0097 U	0.0094 U	0.008 U	0.0084 U	0.0097 U	0.0098 U
CADMIUM	0.1181 B	0.0291 U	0.0282 U	0.024 U	0.1146 B	0.029 U	0.0293 U
CALCIUM	10500	5854.369	5286.385	5744	12159	9086.957	6317.073
CHROMIUM TOTAL	0.3209 B	0.146 B	0.2705 B	0.2909 B	0.4619	0.3117 B	0.2466 B
COBALT	0.0586 U	0.0631 U	0.061 U	0.0649 B	0.0544 U	0.0628 U	0.0634 U
COPPER	5.0856	1.8786	3.0925	3.228	3.7046	3.7575	2.9951
IRON	68.8739	35.1942	58.4507	58.88	118.2008	71.401	53.2195
LEAD	0.1763	0.1117 U	0.108 U	0.092 U	1.1544	0.2683	0.1122 U
MAGNESIUM	413.8288	282.3301	362.0657	406.4	371.5481	603.8647	421.122
MANGANESE	8.1802	4.0422	10.6103	6.2	2.518	7.7923	9.3024
MERCURY	0.0303	0.0089 U	0.0075 U	0.0093	0.0371	0.0088 U	0.0053 U
NICKEL	0.1126 U	0.1878 B	0.1519 B	0.1966 B	0.1046 U	0.2646 B	0.4336 B
POTASSIUM	2937.838	1965.534	3007.512	3020	2623.013	3611.111	2818.049
SELENIUM	0.7373	0.279	0.4285	0.5673	0.8921	0.8256	0.645
SILVER	0.0676 U	0.0728 U	0.0704 U	0.06 U	0.0628 U	0.0725 U	0.0732 U
SODIUM	1278.378	867.9612	1149.765	1236.4	1286.192	1360.87	1052.683
THALLIUM	0.1847 U	0.199 U	0.1925 U	0.164 U	0.1715 U	0.1981 U	0.2142 B
VANADIUM	0.3658 B	0.0777 U	0.2473 B	0.2548 B	0.2588 B	0.2818 B	0.11 B
ZINC	34.6351	17.8398	24.3474	24.108	34.6318	32.256	32.0098

TABLE A1-2
PLANT ANALYTICAL DATA USED IN THE ENVIRONMENTAL RISK CHARACTERIZATION

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

Analyte	LOCATION			
	PL001WDX	PL002WDX	PL003WMD	PL004WMD
SVOCs (mg/kg)				
1,2,4-Trichlorobenzene	NA	NA	NA	NA
1,3-Dichlorobenzene	NA	NA	NA	NA
1,2-Dichlorobenzene	NA	NA	NA	NA
1,4-Dichlorobenzene	NA	NA	NA	NA
2,2'-oxybis(1-Chloropropane)	NA	NA	NA	NA
2,3,6-Trichlorophenol	NA	NA	NA	NA
2,4,5-Trichlorophenol	NA	NA	NA	NA
2,4,6-Trichlorophenol	NA	NA	NA	NA
2,4-Dichlorophenol	NA	NA	NA	NA
2,4-Dimethylphenol	NA	NA	NA	NA
2,4-Dinitrophenol	NA	NA	NA	NA
2,4-Dinitrotoluene	NA	NA	NA	NA
2,6-Dinitrotoluene	NA	NA	NA	NA
2-Chloronaphthalene	NA	NA	NA	NA
2-Chlorophenol	NA	NA	NA	NA
2-Nitrophenol	NA	NA	NA	NA
3,3'-Dichlorobenzidine	NA	NA	NA	NA
4,6-Dinitro2methylphenol	NA	NA	NA	NA
4-Bromophenyl-phenylether	NA	NA	NA	NA
4-Chloro-3-Methylphenol	NA	NA	NA	NA
4-Chlorophenylphenylether	NA	NA	NA	NA
4-Nitrophenol	NA	NA	NA	NA
Acenaphthene	NA	NA	NA	NA
Acenaphthylene	NA	NA	NA	NA
Anthracene	NA	NA	NA	NA
Azobenzene	NA	NA	NA	NA
Benzidine	NA	NA	NA	NA
Benzo(a)anthracene	NA	NA	NA	NA
Benzo(a)pyrene	NA	NA	NA	NA
Benzo(b)fluoranthene	NA	NA	NA	NA
Benzo(g,h,i)perylene	NA	NA	NA	NA
Benzo(k)fluoranthene	NA	NA	NA	NA
Biphenyl	NA	NA	NA	NA
bis(2-Chloroethyl)Ether	NA	NA	NA	NA
bis(2Ethylhexyl)phthalate	NA	NA	NA	NA
Butylbenzylphthalate	NA	NA	NA	NA
Carbazole	NA	NA	NA	NA
Chrysene	NA	NA	NA	NA
Di-n-butylphthalate	NA	NA	NA	NA
Di-n-octylphthalate	NA	NA	NA	NA
Dibenz(a,h)anthracene	NA	NA	NA	NA
Dibenzofuran	NA	NA	NA	NA
Dibenzothiophene	NA	NA	NA	NA
Diethylphthalate	NA	NA	NA	NA
Dimethylphthalate	NA	NA	NA	NA
Fluoranthene	NA	NA	NA	NA
Fluorene	NA	NA	NA	NA

TABLE A1-2
PLANT ANALYTICAL DATA USED IN THE ENVIRONMENTAL RISK CHARACTERIZATION

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

Analyte	LOCATION			
	PL001WDX	PL002WDX	PL003WMD	PL004WMD
SVOCs (mg/kg) cont.				
Hexachlorobenzene	NA	NA	NA	NA
Hexachlorobutadiene	NA	NA	NA	NA
Hexachlorocyclopentadiene	NA	NA	NA	NA
Hexachloroethane	NA	NA	NA	NA
Indeno(1,2,3-cd)pyrene	NA	NA	NA	NA
Isophorone	NA	NA	NA	NA
N-Nitrosodimethylamine	NA	NA	NA	NA
N-Nitrosodinpropylamine	NA	NA	NA	NA
Naphthalene	NA	NA	NA	NA
N-Nitrosodiphenylamine	NA	NA	NA	NA
Nitrobenzene	NA	NA	NA	NA
Phenanthrene	NA	NA	NA	NA
Pentachlorophenol	NA	NA	NA	NA
Phenol	NA	NA	NA	NA
Pyrene	NA	NA	NA	NA
PESTICIDES (mg/kg)				
4,4'-DDD	0.0033 U	0.0033 U	0.0033 U	0.0033 U
4,4'-DDE	0.0033 U	0.0033 U	0.0033 U	0.0033 U
4,4'-DDT	0.0033 U	0.0033 U	0.0033 U	0.0033 U
Aldrin	0.0017 U	0.0017 U	0.0017 U	0.0017 U
alpha-BHC	0.0017 U	0.0009 J	0.0009 J	0.001 J
alpha-Chlordane	0.0017 U	0.0017 U	0.0009 J	0.0011 J
Aroclor-1016	0.033 U	0.033 U	0.033 U	0.033 U
Aroclor-1221	0.067 U	0.067 U	0.067 U	0.067 U
Aroclor-1232	0.033 U	0.033 U	0.033 U	0.033 U
Aroclor-1242	0.033 U	0.033 U	0.033 U	0.033 U
Aroclor-1248	0.033 U	0.033 U	0.033 U	0.033 U
Aroclor-1254	0.033 U	0.033 U	0.033 U	0.033 U
Aroclor-1260	0.033 U	0.033 U	0.033 U	0.033 U
beta-BHC	0.0017 U	0.0017 U	0.0017 U	0.0017 U
delta-BHC	0.0017 U	0.0017 U	0.0029 P	0.002 P
Dieldrin	0.0033 U	0.0033 U	0.0033 U	0.0033 U
Endosulfan I	0.0017 U	0.0017 U	0.0017 U	0.0017 U
Endosulfan sulfate	0.0033 U	0.0033 U	0.0033 U	0.0033 U
Endosulfan II	0.0033 U	0.0033 U	0.0033 U	0.0033 U
Endrin	0.0033 U	0.0033 U	0.0033 U	0.0033 U
Endrin ketone	0.0033 U	0.0033 U	0.0033 U	0.0033 U
Endrin aldehyde	0.0033 U	0.0033 U	0.0033 U	0.0033 U
gamma-BHC (Lindane)	0.0017 U	0.0017 U	0.0012 J	0.001 J
gamma-Chlordane	0.0017 U	0.0017 U	0.0017 U	0.0017 U
Heptachlor	0.0017 U	0.0017 U	0.0011 J	0.0017 U
Heptachlor Epoxide	0.0017 U	0.0017 U	0.0017 U	0.0017 U
p,p'-Methoxychlor	0.017 U	0.017 U	0.017 U	0.017 U
Toxaphene	0.17 U	0.17 U	0.17 U	0.17 U

TABLE A1-2
PLANT ANALYTICAL DATA USED IN THE ENVIRONMENTAL RISK CHARACTERIZATION

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

Analyte	LOCATION			
	PL001WDX	PL002WDX	PL003WMD	PL004WMD
METALS (mg/kg)				
ALUMINUM	34.0375	40.1953	124.5783	89.3555
ANTIMONY	0.15 U	0.1674 U	0.1735 U	0.1497 U
ARSENIC	0.1167 U	0.1302 U	0.1349 U	0.1164 U
BARIUM	3.4388 B	0.8256 B	1.9735 B	1.5106 B
BERYLLIUM	0.0125 U	0.014 U	0.0145 U	0.0125 U
CADMIUM	0.0258 B	0.0258 B	0.0298 B	0.0227 B
CALCIUM	952.0833	1488.8372	617.3494	739.7089
CHROMIUM TOTAL	0.4908	0.2151 B	8.4434	0.689
COBALT	0.0958 U	0.107 U	0.2973 B	0.0981 B
COPPER	1.4592	0.7074 B	3.1022	1.1289
IRON	143.5833	60.8372	254.3133	90.7277
LEAD	0.8063	0.134 B	0.3419	0.3685
MAGNESIUM	327.0417	115.907 B	217.253 B	278.7526
MANGANESE	46.9583	5.6558	72.4819	62.7443
MERCURY	0.0091 U	0.0093 U	0.0092 B	0.01 U
NICKEL	0.2084 B	0.2089 B	0.5716 B	0.5064 B
POTASSIUM	1687.9166	2333.0232	2634.2168	2362.5779
SELENIUM	0.2305	0.1442 U	0.1733 B	0.2158
SILVER	0.05 U	0.0558 U	0.0578 U	0.0499 U
SODIUM	957.0833	659.5349	133.0602 B	172.474 B
THALLIUM	0.1655 B	0.1674 U	0.1997 B	0.1861 B
VANADIUM	0.5588 B	0.0837 U	0.1825 B	0.187 B
ZINC	25.8292	4.9628	12.2651	15.1892

TABLE A1-3
CRAYFISH ANALYTICAL DATA USED IN THE ENVIRONMENTAL RISK CHARACTERIZATION

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

	LOCATION				
ANALYTE	CF001WDX	CF002WDX	CF003WDX	CF004WDX	CF005STD
SVOCs (mg/kg)					
1,2,4-Trichlorobenzene	0.12 U	NA	0.098 U	NA	NA
1,3-Dichlorobenzene	0.12 U	NA	0.098 U	NA	NA
1,2-Dichlorobenzene	0.12 U	NA	0.098 U	NA	NA
1,4-Dichlorobenzene	0.12 U	NA	0.098 U	NA	NA
2,2'-oxybis(1-Chloropropane)	0.12 U	NA	0.098 U	NA	NA
2,3,6-Trichlorophenol	0.12 U	NA	0.098 U	NA	NA
2,4,5-Trichlorophenol	0.12 U	NA	0.098 U	NA	NA
2,4,6-Trichlorophenol	0.12 U	NA	0.098 U	NA	NA
2,4-Dichlorophenol	0.12 U	NA	0.098 U	NA	NA
2,4-Dimethylphenol	0.12 U	NA	0.098 U	NA	NA
2,4-Dinitrophenol	0.12 U	NA	0.098 U	NA	NA
2,4-Dinitrotoluene	0.12 U	NA	0.098 U	NA	NA
2,6-Dinitrotoluene	0.12 U	NA	0.098 U	NA	NA
2-Chloronaphthalene	0.12 U	NA	0.098 U	NA	NA
2-Chlorophenol	0.12 U	NA	0.098 U	NA	NA
2-Nitrophenol	0.12 U	NA	0.098 U	NA	NA
3,3'-Dichlorobenzidine	0.12 U	NA	0.098 U	NA	NA
4,6-Dinitro2methylphenol	0.12 U	NA	0.098 U	NA	NA
4-Bromophenyl-phenylether	0.12 U	NA	0.098 U	NA	NA
4-Chloro-3-Methylphenol	0.12 U	NA	0.098 U	NA	NA
4-Chlorophenylphenylether	0.12 U	NA	0.098 U	NA	NA
4-Nitrophenol	0.61 U	NA	0.49 U	NA	NA
Acenaphthene	0.12 U	NA	0.098 U	NA	NA
Acenaphthylene	0.12 U	NA	0.098 U	NA	NA
Anthracene	0.12 U	NA	0.098 U	NA	NA
Azobenzene	0.12 U	NA	0.098 U	NA	NA
Benzidine	0.12 U	NA	0.098 U	NA	NA
Benzo(a)anthracene	0.12 U	NA	0.098 U	NA	NA
Benzo(a)pyrene	0.12 U	NA	0.098 U	NA	NA
Benzo(b)fluoranthene	0.12 U	NA	0.098 U	NA	NA
Benzo(g,h,i)perylene	0.12 U	NA	0.098 U	NA	NA
Benzo(k)fluoranthene	0.12 U	NA	0.098 U	NA	NA
Biphenyl	0.12 U	NA	0.098 U	NA	NA

TABLE A1-3
CRAYFISH ANALYTICAL DATA USED IN THE ENVIRONMENTAL RISK CHARACTERIZATION

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

	LOCATION				
ANALYTE	CF001WDX	CF002WDX	CF003WDX	CF004WDX	CF005STD
SVOCs (mg/kg) cont.					
bis(2-Chloroethyl)Ether	0.12 U	NA	0.098 U	NA	NA
bis(2Ethylhexyl)phthalate	5.9	NA	0.098 U	NA	NA
Butylbenzylphthalate	0.12 U	NA	0.098 U	NA	NA
Carbazole	0.12 U	NA	0.098 U	NA	NA
Chrysene	0.12 U	NA	0.098 U	NA	NA
Di-n-butylphthalate	0.12 U	NA	0.098 U	NA	NA
Di-n-octylphthalate	0.12 U	NA	0.098 U	NA	NA
Dibenz(a,h)anthracene	0.12 U	NA	0.098 U	NA	NA
Dibenzofuran	0.12 U	NA	0.098 U	NA	NA
Dibenzothiophene	0.12 U	NA	0.098 U	NA	NA
Diethylphthalate	0.12 U	NA	0.098 U	NA	NA
Dimethylphthalate	0.12 U	NA	0.098 U	NA	NA
Fluoranthene	0.12 U	NA	0.098 U	NA	NA
Fluorene	0.12 U	NA	0.098 U	NA	NA
Hexachlorobenzene	0.12 U	NA	0.098 U	NA	NA
Hexachlorobutadiene	0.12 U	NA	0.098 U	NA	NA
Hexachlorocyclopentadiene	0.12 U	NA	0.098 U	NA	NA
Hexachloroethane	0.12 U	NA	0.098 U	NA	NA
Indeno(1,2,3-cd)pyrene	0.12 U	NA	0.098 U	NA	NA
Isophorone	0.12 U	NA	0.098 U	NA	NA
N-Nitrosodimethylamine	0.12 U	NA	0.098 U	NA	NA
N-Nitrosodinpropylamine	0.12 U	NA	0.098 U	NA	NA
Naphthalene	0.12 U	NA	0.098 U	NA	NA
N-Nitrosodiphenylamine	0.12 U	NA	0.098 U	NA	NA
Nitrobenzene	0.12 U	NA	0.098 U	NA	NA
Phenanthrene	0.12 U	NA	0.098 U	NA	NA
Pentachlorophenol	0.12 U	NA	0.098 U	NA	NA
Phenol	0.12 U	NA	0.16	NA	NA
Pyrene	0.12 U	NA	0.098 U	NA	NA

TABLE A1-3
CRAYFISH ANALYTICAL DATA USED IN THE ENVIRONMENTAL RISK CHARACTERIZATION

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

	LOCATION				
ANALYTE	CF001WDX	CF002WDX	CF003WDX	CF004WDX	CF005STD
PESTICIDES (mg/kg)					
4,4'-DDD	0.0033 U	0.0032 U	0.0033 U	0.0033 U	0.0033 U
4,4'-DDE	0.0033 U	0.0032 U	0.0033 U	0.0033 U	0.0033 U
4,4'-DDT	0.0033 U	0.0032 U	0.0033 U	0.0033 U	0.0033 U
Aldrin	0.0017 U	0.0017 U	0.0017 U	0.0017 U	0.0017 U
alpha-BHC	0.0017 U	0.0017 U	0.0017 U	0.0017 U	0.0017 U
alpha-Chlordane	0.0017 U	0.0017 U	0.0017 U	0.0017 U	0.0017 U
Aroclor-1016	0.033 U	0.032 U	0.033 U	0.033 U	0.033 U
Aroclor-1221	0.067 U	0.066 U	0.067 U	0.067 U	0.067 U
Aroclor-1232	0.033 U	0.032 U	0.033 U	0.033 U	0.033 U
Aroclor-1242	0.033 U	0.032 U	0.033 U	0.033 U	0.033 U
Aroclor-1248	0.033 U	0.032 U	0.033 U	0.033 U	0.033 U
Aroclor-1254	0.033 U	0.032 U	0.033 U	0.033 U	0.033 U
Aroclor-1260	0.033 U	0.032 U	0.033 U	0.033 U	0.033 U
beta-BHC	0.0017 U	0.0017 U	0.0017 U	0.0017 U	0.0017 U
delta-BHC	0.0017 U	0.0017 U	0.0017 U	0.0017 U	0.0017 U
Dieldrin	0.0033 U	0.0032 U	0.0033 U	0.0033 U	0.0033 U
Endosulfan I	0.0017 U	0.0017 U	0.0017 U	0.0017 U	0.0017 U
Endosulfan sulfate	0.0033 U	0.0032 U	0.0033 U	0.0033 U	0.0033 U
Endosulfan II	0.0033 U	0.0032 U	0.0033 U	0.0033 U	0.0033 U
Endrin	0.0033 U	0.0032 U	0.0033 U	0.0033 U	0.0033 U
Endrin ketone	0.0033 U	0.0032 U	0.0033 U	0.0033 U	0.0033 U
Endrin aldehyde	0.0033 U	0.0032 U	0.0033 U	0.0033 U	0.0033 U
gamma-BHC (Lindane)	0.0017 U	0.0017 U	0.0017 U	0.0017 U	0.0017 U
gamma-Chlordane	0.0017 U	0.0017 U	0.0017 U	0.0017 U	0.0017 U
Heptachlor	0.0017 U	0.0017 U	0.0017 U	0.0017 U	0.0017 U
Heptachlor Epoxide	0.0017 U	0.0017 U	0.0017 U	0.0017 U	0.0017 U
p,p'-Methoxychlor	0.017 U	0.017 U	0.017 U	0.017 U	0.017 U
Toxaphene	0.17 U	0.17 U	0.17 U	0.17 U	0.17 U

TABLE A1-3
CRAYFISH ANALYTICAL DATA USED IN THE ENVIRONMENTAL RISK CHARACTERIZATION

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

	LOCATION				
ANALYTE	CF001WDX	CF002WDX	CF003WDX	CF004WDX	CF005STD
METALS (mg/kg)					
ALUMINUM	107.3804	152.9004	93.0283	80.8715	73.2084
ANTIMONY	0.164 U	0.1558 U	0.1569 U	0.1569 U	0.1686 U
ARSENIC	0.394 B	0.3463 B	0.2771 B	0.2028 B	0.2815 B
BARIUM	17.1526	20.2078	26.4967	19.9913	13.8407
BERYLLIUM	0.0137 U	0.013 U	0.0131 U	0.0131 U	0.0141 U
CADMIUM	0.0534 B	0.0496 B	0.0546 B	0.0515 B	0.0598 B
CALCIUM	35138.952	38125.541	50370.37	45664.488	34402.81
CHROMIUM TOTAL	23.9408	30.0823	11.4684	7.5338	7.9672
COBALT	0.3118 B	0.3432 B	0.3083 B	0.3919 B	0.2706 B
COPPER	35.7358	30	32.3137	33.024	31.7564
IRON	249.1116	340.7792	206.7538	224.793	219.0632
LEAD	0.341	0.5134	0.6584	0.2603	0.2745
MAGNESIUM	277.4487	522.5108	320.9586	301.22	273.5831
MANGANESE	30.3007	38.1775	44.5316	66.9717	29.7143
MERCURY	0.029	0.0281	0.0229	0.0307	0.0274
NICKEL	0.1649 B	0.2693 B	0.1403 B	0.1636 B	0.1218 U
POTASSIUM	1779.4988	1810.8225	1952.5054	1989.9782	1903.0444
SELENIUM	0.431	0.3328	0.3378	0.3074	0.3989
SILVER	0.0579 B	0.0589 B	0.0755 B	0.0827 B	0.0785 B
SODIUM	2101.1389	1934.1991	2084.9673	2178.2135	2237.4707
THALLIUM	0.2122 B	0.1558 U	0.1569 U	0.1569 U	0.1686 U
VANADIUM	0.5526 B	0.5926 B	0.3072 B	0.3384 B	0.4519 B
ZINC	27.4989	28.5368	27.3159	33.9085	30.0656

TABLE A1-3
CRAYFISH ANALYTICAL DATA USED IN THE ENVIRONMENTAL RISK CHARACTERIZATION

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

	LOCATION			
ANALYTE	CF006STD	CF007STD	CF008STD	CF009REF
SVOCs (mg/kg)				
1,2,4-Trichlorobenzene	0.098 U	0.098 U	NA	NA
1,3-Dichlorobenzene	0.098 U	0.098 U	NA	NA
1,2-Dichlorobenzene	0.098 U	0.098 U	NA	NA
1,4-Dichlorobenzene	0.098 U	0.098 U	NA	NA
2,2'-oxybis(1-Chloropropane)	0.098 U	0.098 U	NA	NA
2,3,6-Trichlorophenol	0.098 U	0.098 U	NA	NA
2,4,5-Trichlorophenol	0.098 U	0.098 U	NA	NA
2,4,6-Trichlorophenol	0.098 U	0.098 U	NA	NA
2,4-Dichlorophenol	0.098 U	0.098 U	NA	NA
2,4-Dimethylphenol	0.098 U	0.098 U	NA	NA
2,4-Dinitrophenol	0.098 U	0.098 U	NA	NA
2,4-Dinitrotoluene	0.098 U	0.098 U	NA	NA
2,6-Dinitrotoluene	0.098 U	0.098 U	NA	NA
2-Chloronaphthalene	0.098 U	0.098 U	NA	NA
2-Chlorophenol	0.098 U	0.098 U	NA	NA
2-Nitrophenol	0.098 U	0.098 U	NA	NA
3,3'-Dichlorobenzidine	0.098 U	0.098 U	NA	NA
4,6-Dinitro2methylphenol	0.098 U	0.098 U	NA	NA
4-Bromophenyl-phenylether	0.098 U	0.098 U	NA	NA
4-Chloro-3-Methylphenol	0.098 U	0.098 U	NA	NA
4-Chlorophenylphenylether	0.098 U	0.098 U	NA	NA
4-Nitrophenol	0.49 U	0.49 U	NA	NA
Acenaphthene	0.098 U	0.098 U	NA	NA
Acenaphthylene	0.098 U	0.098 U	NA	NA
Anthracene	0.098 U	0.098 U	NA	NA
Azobenzene	0.098 U	0.098 U	NA	NA
Benzidine	0.098 U	0.098 U	NA	NA
Benzo(a)anthracene	0.098 U	0.098 U	NA	NA
Benzo(a)pyrene	0.098 U	0.098 U	NA	NA
Benzo(b)fluoranthene	0.098 U	0.098 U	NA	NA
Benzo(g,h,i)perylene	0.098 U	0.098 U	NA	NA
Benzo(k)fluoranthene	0.098 U	0.098 U	NA	NA
Biphenyl	0.098 U	0.098 U	NA	NA

TABLE A1-3
CRAYFISH ANALYTICAL DATA USED IN THE ENVIRONMENTAL RISK CHARACTERIZATION

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

ANALYTE	LOCATION			
	CF006STD	CF007STD	CF008STD	CF009REF
SVOCs (mg/kg) cont.				
bis(2-Chloroethyl)Ether	0.098 U	0.098 U	NA	NA
bis(2Ethylhexyl)phthalate	0.89	3	NA	NA
Butylbenzylphthalate	0.098 U	0.098 U	NA	NA
Carbazole	0.098 U	0.098 U	NA	NA
Chrysene	0.098 U	0.098 U	NA	NA
Di-n-butylphthalate	0.098 U	0.098 U	NA	NA
Di-n-octylphthalate	0.098 U	0.098 U	NA	NA
Dibenz(a,h)anthracene	0.098 U	0.098 U	NA	NA
Dibenzofuran	0.098 U	0.098 U	NA	NA
Dibenzothiophene	0.098 U	0.098 U	NA	NA
Diethylphthalate	0.098 U	0.098 U	NA	NA
Dimethylphthalate	0.098 U	0.098 U	NA	NA
Fluoranthene	0.098 U	0.098 U	NA	NA
Fluorene	0.098 U	0.098 U	NA	NA
Hexachlorobenzene	0.098 U	0.098 U	NA	NA
Hexachlorobutadiene	0.098 U	0.098 U	NA	NA
Hexachlorocyclopentadiene	0.098 U	0.098 U	NA	NA
Hexachloroethane	0.098 U	0.098 U	NA	NA
Indeno(1,2,3-cd)pyrene	0.098 U	0.098 U	NA	NA
Isophorone	0.098 U	0.098 U	NA	NA
N-Nitrosodimethylamine	0.098 U	0.098 U	NA	NA
N-Nitrosodinpropylamine	0.098 U	0.098 U	NA	NA
Naphthalene	0.098 U	0.098 U	NA	NA
N-Nitrosodiphenylamine	0.098 U	0.098 U	NA	NA
Nitrobenzene	0.098 U	0.098 U	NA	NA
Phenanthrene	0.098 U	0.098 U	NA	NA
Pentachlorophenol	0.098 U	0.098 U	NA	NA
Phenol	0.098 U	0.098 U	NA	NA
Pyrene	0.098 U	0.098 U	NA	NA

TABLE A1-3
CRAYFISH ANALYTICAL DATA USED IN THE ENVIRONMENTAL RISK CHARACTERIZATION

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

	LOCATION			
ANALYTE	CF006STD	CF007STD	CF008STD	CF009REF
PESTICIDES (mg/kg)				
4,4'-DDD	0.0033 U	0.0033 U	0.0032 U	0.0033 U
4,4'-DDE	0.0033 U	0.0033 U	0.0032 U	0.0083
4,4'-DDT	0.0033 U	0.0033 U	0.0032 U	0.0033 U
Aldrin	0.0017 U	0.0017 U	0.0017 U	0.0017 U
alpha-BHC	0.0017 U	0.0017 U	0.0017 U	0.0017 U
alpha-Chlordane	0.0017 U	0.0017 U	0.0017 U	0.0017 U
Aroclor-1016	0.033 U	0.033 U	0.032 U	0.033 U
Aroclor-1221	0.067 U	0.067 U	0.066 U	0.067 U
Aroclor-1232	0.033 U	0.033 U	0.032 U	0.033 U
Aroclor-1242	0.033 U	0.033 U	0.032 U	0.033 U
Aroclor-1248	0.033 U	0.033 U	0.032 U	0.033 U
Aroclor-1254	0.033 U	0.033 U	0.032 U	0.033 U
Aroclor-1260	0.033 U	0.033 U	0.032 U	0.033 U
beta-BHC	0.0017 U	0.0017 U	0.0017 U	0.0017 U
delta-BHC	0.0017 U	0.0017 U	0.0017 U	0.0017 U
Dieldrin	0.0033 U	0.0033 U	0.0032 U	0.0033 U
Endosulfan I	0.0017 U	0.0017 U	0.0017 U	0.0017 U
Endosulfan sulfate	0.0033 U	0.0033 U	0.0032 U	0.0033 U
Endosulfan II	0.0033 U	0.0033 U	0.0032 U	0.0033 U
Endrin	0.0033 U	0.0033 U	0.0032 U	0.0033 U
Endrin ketone	0.0033 U	0.0033 U	0.0032 U	0.0033 U
Endrin aldehyde	0.0033 U	0.0033 U	0.0032 U	0.0033 U
gamma-BHC (Lindane)	0.0017 U	0.0017 U	0.0017 U	0.0017 U
gamma-Chlordane	0.0017 U	0.0017 U	0.0017 U	0.0017 U
Heptachlor	0.0017 U	0.0017 U	0.0017 U	0.0017 U
Heptachlor Epoxide	0.0017 U	0.0017 U	0.0017 U	0.0017 U
p,p'-Methoxychlor	0.017 U	0.017 U	0.017 U	0.017 U
Toxaphene	0.17 U	0.17 U	0.17 U	0.17 U

TABLE A1-3
CRAYFISH ANALYTICAL DATA USED IN THE ENVIRONMENTAL RISK CHARACTERIZATION

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

	LOCATION			
ANALYTE	CF006STD	CF007STD	CF008STD	CF009REF
METALS (mg/kg)				
ALUMINUM	74.383	98.801	91.0913	NA
ANTIMONY	0.1532 U	0.1727 U	0.1604 U	NA
ARSENIC	0.1266 B	0.2168 B	0.1247 U	NA
BARIUM	18.0936	19.9376	12.8775	NA
BERYLLIUM	0.0128 U	0.0144 U	0.0134 U	NA
CADMIUM	0.0503 B	0.0626 B	0.0421 B	NA
CALCIUM	30876.595	33280.575	39657.015	NA
CHROMIUM TOTAL	10.617	16.6187	9.8842	NA
COBALT	0.2797 B	0.3655 B	0.2412 B	NA
COPPER	33.5702	36.1151	35.8085	NA
IRON	177.1915	232.7098	151.8931	NA
LEAD	0.2377	0.2585	0.4189	NA
MAGNESIUM	256.1702	280.2878	228.9087	NA
MANGANESE	29.1234	38.6715	14.1114	NA
MERCURY	0.0248	0.0238	0.0246	NA
NICKEL	0.1524 B	0.1617 B	0.1754 B	NA
POTASSIUM	2001.2765	2107.9136	1745.657	NA
SELENIUM	0.3404	0.4048	0.2268	NA
SILVER	0.0681 B	0.0705 B	0.0841 B	NA
SODIUM	1995.3191	2070.9832	2285.9688	NA
THALLIUM	0.1532 U	0.1951 B	0.1604 U	NA
VANADIUM	0.2479 B	0.3263 B	0.2153 B	NA
ZINC	24.0468	26.8441	26.5791	NA

TABLE A1-4
FROG ANALYTICAL DATA USED IN THE ENVIRONMENTAL RISK CHARACTERIZATION

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

	LOCATION						
ANALYTE	FR002PND	FR001PND	FR003STD	FR004WDX	FR005PND	FR006PND	FR007WDX
SVOCs (mg/kg)							
1,2,4-Trichlorobenzene	NA	0.098 U	NA	NA	0.1 U	0.1 U	0.098 U
1,3-Dichlorobenzene	NA	0.098 U	NA	NA	0.1 U	0.1 U	0.098 U
1,2-Dichlorobenzene	NA	0.098 U	NA	NA	0.1 U	0.1 U	0.098 U
1,4-Dichlorobenzene	NA	0.098 U	NA	NA	0.1 U	0.1 U	0.098 U
2,2'-oxybis(1-Chloropropane)	NA	0.098 U	NA	NA	0.1 U	0.1 U	0.098 U
2,3,6-Trichlorophenol	NA	0.098 U	NA	NA	0.1 U	0.1 U	0.098 U
2,4,5-Trichlorophenol	NA	0.098 U	NA	NA	0.1 U	0.1 U	0.098 U
2,4,6-Trichlorophenol	NA	0.098 U	NA	NA	0.1 U	0.1 U	0.098 U
2,4-Dichlorophenol	NA	0.098 U	NA	NA	0.1 U	0.1 U	0.098 U
2,4-Dimethylphenol	NA	0.098 U	NA	NA	0.1 U	0.1 U	0.098 U
2,4-Dinitrophenol	NA	0.098 U	NA	NA	0.1 U	0.1 U	0.098 U
2,4-Dinitrotoluene	NA	0.098 U	NA	NA	0.1 U	0.1 U	0.098 U
2,6-Dinitrotoluene	NA	0.098 U	NA	NA	0.1 U	0.1 U	0.098 U
2-Chloronaphthalene	NA	0.098 U	NA	NA	0.1 U	0.1 U	0.098 U
2-Chlorophenol	NA	0.098 U	NA	NA	0.1 U	0.1 U	0.098 U
2-Nitrophenol	NA	0.098 U	NA	NA	0.1 U	0.1 U	0.098 U
3,3'-Dichlorobenzidine	NA	0.098 U	NA	NA	0.1 U	0.1 U	0.098 U
4,6-Dinitro2methylphenol	NA	0.098 U	NA	NA	0.1 U	0.1 U	0.098 U
4-Bromophenyl-phenylether	NA	0.098 U	NA	NA	0.1 U	0.1 U	0.098 U
4-Chloro-3-Methylphenol	NA	0.098 U	NA	NA	0.1 U	0.1 U	0.098 U
4-Chlorophenylphenylether	NA	0.098 U	NA	NA	0.1 U	0.1 U	0.098 U
4-Nitrophenol	NA	0.49 U	NA	NA	0.5 U	0.5 U	0.49 U
Acenaphthene	NA	0.098 U	NA	NA	0.1 U	0.1 U	0.098 U
Acenaphthylene	NA	0.098 U	NA	NA	0.1 U	0.1 U	0.098 U
Anthracene	NA	0.098 U	NA	NA	0.1 U	0.1 U	0.098 U
Azobenzene	NA	0.098 U	NA	NA	0.1 U	0.1 U	0.098 U
Benzidine	NA	0.098 U	NA	NA	0.1 U	0.1 U	0.098 U
Benzo(a)anthracene	NA	0.098 U	NA	NA	0.1 U	0.1 U	0.098 U
Benzo(a)pyrene	NA	0.098 U	NA	NA	0.1 U	0.1 U	0.098 U
Benzo(b)fluoranthene	NA	0.098 U	NA	NA	0.1 U	0.1 U	0.098 U
Benzo(g,h,i)perylene	NA	0.098 U	NA	NA	0.1 U	0.1 U	0.098 U
Benzo(k)fluoranthene	NA	0.098 U	NA	NA	0.1 U	0.1 U	0.098 U
Biphenyl	NA	0.098 U	NA	NA	0.1 U	0.1 U	0.098 U

TABLE A1-4
FROG ANALYTICAL DATA USED IN THE ENVIRONMENTAL RISK CHARACTERIZATION

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

	LOCATION						
ANALYTE	FR002PND	FR001PND	FR003STD	FR004WDX	FR005PND	FR006PND	FR007WDX
SVOCs (mg/kg) cont.							
bis(2-Chloroethyl)Ether	NA	0.098 U	NA	NA	0.1 U	0.1 U	0.098 U
bis(2Ethylhexyl)phthalate	NA	12 D	NA	NA	14 D	23 D	0.22
Butylbenzylphthalate	NA	0.098 U	NA	NA	0.1 U	0.1 U	0.098 U
Carbazole	NA	0.098 U	NA	NA	0.1 U	0.1 U	0.098 U
Chrysene	NA	0.098 U	NA	NA	0.1 U	0.1 U	0.098 U
Di-n-butylphthalate	NA	0.098 U	NA	NA	0.1 U	0.1 U	0.098 U
Di-n-octylphthalate	NA	0.098 U	NA	NA	0.1 U	0.1 U	0.098 U
Dibenz(a,h)anthracene	NA	0.098 U	NA	NA	0.1 U	0.1 U	0.098 U
Dibenzofuran	NA	0.098 U	NA	NA	0.1 U	0.1 U	0.098 U
Dibenzothiophene	NA	0.098 U	NA	NA	0.1 U	0.1 U	0.098 U
Diethylphthalate	NA	0.098 U	NA	NA	0.1 U	0.1 U	0.098 U
Dimethylphthalate	NA	0.098 U	NA	NA	0.1 U	0.1 U	0.098 U
Fluoranthene	NA	0.098 U	NA	NA	0.1 U	0.1 U	0.098 U
Fluorene	NA	0.098 U	NA	NA	0.1 U	0.1 U	0.098 U
Hexachlorobenzene	NA	0.098 U	NA	NA	0.1 U	0.1 U	0.098 U
Hexachlorobutadiene	NA	0.098 U	NA	NA	0.1 U	0.1 U	0.098 U
Hexachlorocyclopentadiene	NA	0.098 U	NA	NA	0.1 U	0.1 U	0.098 U
Hexachloroethane	NA	0.098 U	NA	NA	0.1 U	0.1 U	0.098 U
Indeno(1,2,3-cd)pyrene	NA	0.098 U	NA	NA	0.1 U	0.1 U	0.098 U
Isophorone	NA	0.098 U	NA	NA	0.1 U	0.1 U	0.098 U
N-Nitrosodimethylamine	NA	0.098 U	NA	NA	0.1 U	0.1 U	0.098 U
N-Nitrosodinpropylamine	NA	0.098 U	NA	NA	0.1 U	0.1 U	0.098 U
Naphthalene	NA	0.098 U	NA	NA	0.1 U	0.1 U	0.098 U
N-Nitrosodiphenylamine	NA	0.098 U	NA	NA	0.1 U	0.1 U	0.098 U
Nitrobenzene	NA	0.098 U	NA	NA	0.1 U	0.1 U	0.098 U
Phenanthrene	NA	0.098 U	NA	NA	0.1 U	0.1 U	0.098 U
Pentachlorophenol	NA	0.098 U	NA	NA	0.1 U	0.1 U	0.098 U
Phenol	NA	0.098 U	NA	NA	0.1 U	0.1 U	0.098 U
Pyrene	NA	0.098 U	NA	NA	0.1 U	0.1 U	0.098 U

TABLE A1-4
FROG ANALYTICAL DATA USED IN THE ENVIRONMENTAL RISK CHARACTERIZATION

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

	LOCATION						
ANALYTE	FR002PND	FR001PND	FR003STD	FR004WDX	FR005PND	FR006PND	FR007WDX
PESTICIDES (mg/kg)							
4,4'-DDD	0.0032 U	0.0046 P	0.0033 U	0.0032 U	0.0015 JP	0.0032 U	0.0032 U
4,4'-DDE	0.0017 JP	0.0018 J	0.0033 U	0.0032 U	0.0022 J	0.002 JP	0.0021 J
4,4'-DDT	0.0028 JP	0.0064 P	0.0031 JP	0.0032 U	0.0052 P	0.0053 P	0.0032 U
Aldrin	0.0017 U	0.0017 U	0.0017 U	0.0017 U	0.0018 P	0.0022 P	0.0017 U
alpha-BHC	0.0017 U	0.0009 J	0.0017 U	0.0017 U	0.0017 U	0.0017 U	0.0017 U
alpha-Chlordane	0.0017 U	0.003 P	0.0017 U	0.0017 U	0.0012 JP	0.0012 JP	0.0017 U
Aroclor-1016	NA	0.032 U	NA	0.032 U	NA	NA	NA
Aroclor-1221	NA	0.066 U	NA	0.066 U	NA	NA	NA
Aroclor-1232	NA	0.032 U	NA	0.032 U	NA	NA	NA
Aroclor-1242	NA	0.032 U	NA	0.032 U	NA	NA	NA
Aroclor-1248	NA	0.032 U	NA	0.032 U	NA	NA	NA
Aroclor-1254	NA	0.032 U	NA	0.032 U	NA	NA	NA
Aroclor-1260	NA	0.032 U	NA	0.032 U	NA	NA	NA
beta-BHC	0.0017 U	0.0017 U	0.0017 U	0.0017 U	0.0013 JP	0.0012 JP	0.0017 U
delta-BHC	0.0017 U	0.0017 U	0.0017 U	0.0017 U	0.0017 U	0.0017 U	0.0017 U
Dieldrin	0.0032 U	0.0032 U	0.0033 U	0.0032 U	0.0032 U	0.0032 U	0.0032 U
Endosulfan I	0.0017 U	0.0017 U	0.0017 U	0.0017 U	0.0017 U	0.0017 U	0.0017 U
Endosulfan sulfate	0.0032 U	0.0209 P	0.0019 J	0.0022 J	0.016 P	0.02 P	0.0022 J
Endosulfan II	0.0032 U	0.0046 P	0.0033 U	0.0032 U	0.0032 U	0.0032 U	0.0032 U
Endrin	0.0032 U	0.0032 U	0.0033 U	0.0032 U	0.0034 P	0.0035 P	0.0032 U
Endrin ketone	0.0032 U	0.0032 U	0.0033 U	0.0032 U	0.0032 U	0.0032 U	0.0032 U
Endrin aldehyde	0.0032 U	0.0032 U	0.0033 U	0.0032 U	0.0032 JP	0.0027 JP	0.0032 U
gamma-BHC (Lindane)	0.0017 U	0.0015 J	0.0017 U	0.0017 U	0.0011 J	0.0012 J	0.0017 U
gamma-Chlordane	0.0017 U	0.0017 U	0.0017 U	0.0017 U	0.0017 U	0.0017 U	0.0017 U
Heptachlor	0.0017 U	0.0017 U	0.0017 U	0.0017 U	0.0017 U	0.0017 U	0.0017 U
Heptachlor Epoxide	0.0017 U	0.0008 J	0.0017 U	0.0009 J	0.0017 U	0.0028 P	0.0014 JP
p,p'-Methoxychlor	0.017 U	0.0142 J	0.017 U	0.017 U	0.032 P	0.053 P	0.017 U
Toxaphene	0.17 U	0.17 U	0.17 U	0.17 U	0.17 U	0.17 U	0.17 U

TABLE A1-4
FROG ANALYTICAL DATA USED IN THE ENVIRONMENTAL RISK CHARACTERIZATION

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

	LOCATION						
ANALYTE	FR002PND	FR001PND	FR003STD	FR004WDX	FR005PND	FR006PND	FR007WDX
METALS (mg/kg)							
ALUMINUM	6.78 B	294	3.7872 B	10.6741	342.5738	15.8837	10.5261
ANTIMONY	0.15 U	0.3652 B	0.1376 U	0.1607 U	0.5055 B	0.1395 U	0.1205 U
ARSENIC	0.3179 B	0.14 U	0.2018 U	0.125 U	0.1857 U	0.2603 B	0.2224 B
BARIUM	2.7845 B	0.79 B	3.1124 B	4.2875 B	0.7388 B	1.9177 B	1.355 B
BERYLLIUM	0.01 U	0.0217 B	0.0092 U	0.0134 U	0.0282 B	0.0093 U	0.008 U
CADMIUM	0.1425 B	0.0556 B	0.2165 B	0.265	0.0393 B	0.1845 B	0.1879 B
CALCIUM	8125	1155.5	7110.0917	9714.2857	1187.3417	10227.906	5911.6465
CHROMIUM TOTAL	0.3173 B	106.6	0.2043 B	0.338 B	118.1857	1.0116	0.3159 B
COBALT	0.065 U	0.2699 B	0.0596 U	0.1027 U	0.2566 B	0.0605 U	0.0522 U
COPPER	4.0905	2.269	3.4794	2.9085	2.1616	2.1316	2.057
IRON	23.05	599.5	29.4358	39.2545	633.7553	41.4884	31.9438
LEAD	0.1465 B	0.613	0.1308 B	0.1798	0.3242	0.208	0.0924 U
MAGNESIUM	306.3	127.05 B	235.5505	278.9286	105.9072 B	288.1395	231.4458
MANGANESE	14.285	2.6415	31.6789	17.9554	1.7414	8.493	6.7631
MERCURY	0.026	0.0318	0.0191	0.01 U	0.0639	0.0776	0.0304
NICKEL	0.125 U	0.1884 B	0.1147 U	0.1161 U	0.2395 B	0.1507 B	0.1004 U
POTASSIUM	2413.5	1407	2229.3577	2398.2142	1297.0464	2293.0232	2216.4658
SELENIUM	0.3741	0.3289	0.395	0.3967	0.1983 U	0.3087	0.4817
SILVER	0.075 U	0.066 B	0.0688 U	0.0536 U	0.0633 U	0.0698 U	0.0602 U
SODIUM	919.5	1413.5	916.5138	1033.4821	1370.0421	972.093	928.1124
THALLIUM	0.205 U	0.18 U	0.1881 U	0.1607 U	0.173 U	0.1907 U	0.1647 U
VANADIUM	0.0833 B	0.4799 B	0.0858 B	0.1357 B	0.3885 B	0.2006 B	0.1735 B
ZINC	26.235	19.985	19.7936	22.183	21.8565	21.5349	16.8153

TABLE A1-5
EARTHWORM ANALYTICAL DATA USED IN THE ENVIRONMENTAL RISK CHARACTERIZATION

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

Analyte	Sample Location					
	BS013WDXX		BS015SDXX		BS018PNDX	
SVOCs (ug/kg)						
1,2,4-Trichlorobenzene	330	U	480	U	410	U
1,2-Dichlorobenzene	330	U	480	U	410	U
1,3-Dichlorobenzene	330	U	480	U	410	U
1,4-Dichlorobenzene	330	U	480	U	410	U
2,2'-oxybis(1-Chloropropa	330	U	480	U	410	U
2,4,5-Trichlorophenol	1600	U	2300	U	2000	U
2,4,6-Trichlorophenol	330	U	480	U	410	U
2,4-Dichlorophenol	330	U	480	U	410	U
2,4-Dimethylphenol	330	U	480	U	410	U
2,4-Dinitrophenol	1600	U	2300	U	2000	U
2,4-Dinitrotoluene	330	U	480	U	410	U
2,6-Dinitrotoluene	330	U	480	U	410	U
2-Chloronaphthalene	330	U	480	U	410	U
2-Chlorophenol	330	U	480	U	410	U
2-Methylnaphthalene	330	U	480	U	410	U
2-Methylphenol	14	J	55	J	410	U
2-Nitroaniline	1600	U	2300	U	2000	U
2-Nitrophenol	330	U	480	U	410	U
3,3'-Dichlorobenzidine	660	U	960	U	820	U
3-Nitroaniline	1600	U	2300	U	2000	U
4,6-Dinitro-2-methylpheno	1600	U	2300	U	2000	U
4-Bromophenyl-phenylether	330	U	480	U	410	U
4-Chloro-3-methylphenol	330	U	480	U	410	U
4-Chloroaniline	330	U	480	U	410	U
4-Chlorophenyl-phenylethe	330	U	480	U	410	U
4-Methylphenol	330	U	17	J	410	U
4-Nitroaniline	1600	U	2300	U	2000	U
4-Nitrophenol	1600	U	2300	U	2000	U
Acenaphthene	330	U	480	U	410	U
Acenaphthylene	330	U	480	U	410	U
Anthracene	330	U	480	U	410	U
Benzo(a)anthracene	330	U	480	U	410	U
Benzo(a)pyrene	330	U	480	U	410	U
Benzo(b)fluoranthene	330	U	480	U	410	U
Benzo(g,h,i)perylene	330	U	480	U	410	U
Benzo(k)fluoranthene	330	U	480	U	410	U
Benzoic acid	560	J	1000	J	940	J
Benzyl alcohol	330	U	41	J	410	U
bis(2-Chloroethoxy)methan	330	U	480	U	410	U
bis(2-Chloroethyl)ether	330	U	480	U	410	U
bis(2-Ethylhexyl)phthalat	79	JB	22	JB	2100	B
Butylbenzylphthalate	330	U	480	U	410	U

TABLE A1-5
EARTHWORM ANALYTICAL DATA USED IN THE ENVIRONMENTAL RISK CHARACTERIZATION

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

Analyte	Sample Location					
	BS013WDXX		BS015SDXX		BS018PNDX	
SVOCs (ug/kg) cont.						
Carbazole	330	U	480	U	410	U
Chrysene	330	U	480	U	410	U
Di-n-butylphthalate	12	JB	480	U	38	JB
Di-n-octylphthalate	330	U	480	U	410	U
Dibenzo(a,h)anthracene	330	U	480	U	410	U
Dibenzofuran	330	U	480	U	410	U
Diethylphthalate	330	U	480	U	410	U
Dimethylphthalate	330	U	480	U	410	U
Fluoranthene	330	U	480	U	410	U
Fluorene	330	U	480	U	410	U
Hexachlorobenzene	330	U	480	U	410	U
Hexachlorobutadiene	330	U	480	U	410	U
Hexachlorocyclopentadiene	330	U	480	U	410	U
Hexachloroethane	330	U	480	U	410	U
Indeno(1,2,3-cd)pyrene	330	U	480	U	410	U
Isophorone	330	U	480	U	410	U
N-Nitroso-di-n-propylamin	330	U	480	U	410	U
N-Nitrosodiphenylamine (1	330	U	480	U	93	J
Naphthalene	330	U	480	U	410	U
Nitrobenzene	330	U	480	U	410	U
Pentachlorophenol	1600	U	2300	U	2000	U
Phenanthrene	330	U	480	U	410	U
Phenol	330	U	480	U	410	U
Pyrene	330	U	480	U	410	U
PESTICIDES (ug/kg)						
4,4'-DDD	3	U	4	J	10	U
4,4'-DDE	1.3	J	5.6		10	U
4,4'-DDT	2	J	10		11	
Aldrin	2	U	2	U	5	U
alpha-BHC	2	U	2	U	4	J
alpha-Chlordane	2	U	2	U	5	U
beta-BHC	2	U	2	U	2	J
delta-BHC	0.035	J	0.34	J	2	J
Dieldrin	0.23	J	0.92	J	10	U
Endosulfan I	2	U	2	U	5	U
Endosulfan II	3	U	5	U	10	U
Endosulfan Sulfate	3	U	5	U	10	U
Endrin	3	U	5	U	10	U
Endrin aldehyde	3	U	5	U	10	U
Endrin ketone	3	U	5	U	10	U
gamma-BHC (Lindane)	8		17		16	
gamma-Chlordane	2	U	2	U	5	U

TABLE A1-5
EARTHWORM ANALYTICAL DATA USED IN THE ENVIRONMENTAL RISK CHARACTERIZATION

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

	Sample Location		
Analyte	BS013WDXX	BS015SDXX	BS018PNDX
PESTICIDES (ug/kg) cont.			
Heptachlor	2 U	2 U	5 U
Heptachlor Epoxide	2 U	2 U	5 U
Methoxychlor	17 U	23 U	50 U
Toxaphene	33 U	45 U	97 U
METALS (mg/kg)			
Aluminum	841	239	322
Antimony	0.78 U	0.77 U	0.78 U
Arsenic	2 B	1 B	2 B
Barium	2 B	2 B	3 B
Beryllium	0 U	0 U	0 U
Cadmium	4	4	4
Calcium	1030	932 B	1550
Chromium	44	4	30
Cobalt	2 B	2 B	2 B
Copper	2 B	1 B	2 B
Iron	801	329	532
Lead	2	3	3
Magnesium	248 B	114 B	181 B
Manganese	6	2 B	3 B
Mercury	0 U	0	1
Nickel	1 B	0 B	1 B
Potassium	842 B	764 B	856 B
Selenium	3	3	4
Silver	0 U	0 U	0 U
Sodium	797 B	920 B	882 B
Thallium	0 U	0 U	0 U
Vanadium	2 B	1 B	1 B
Zinc	115	65	100

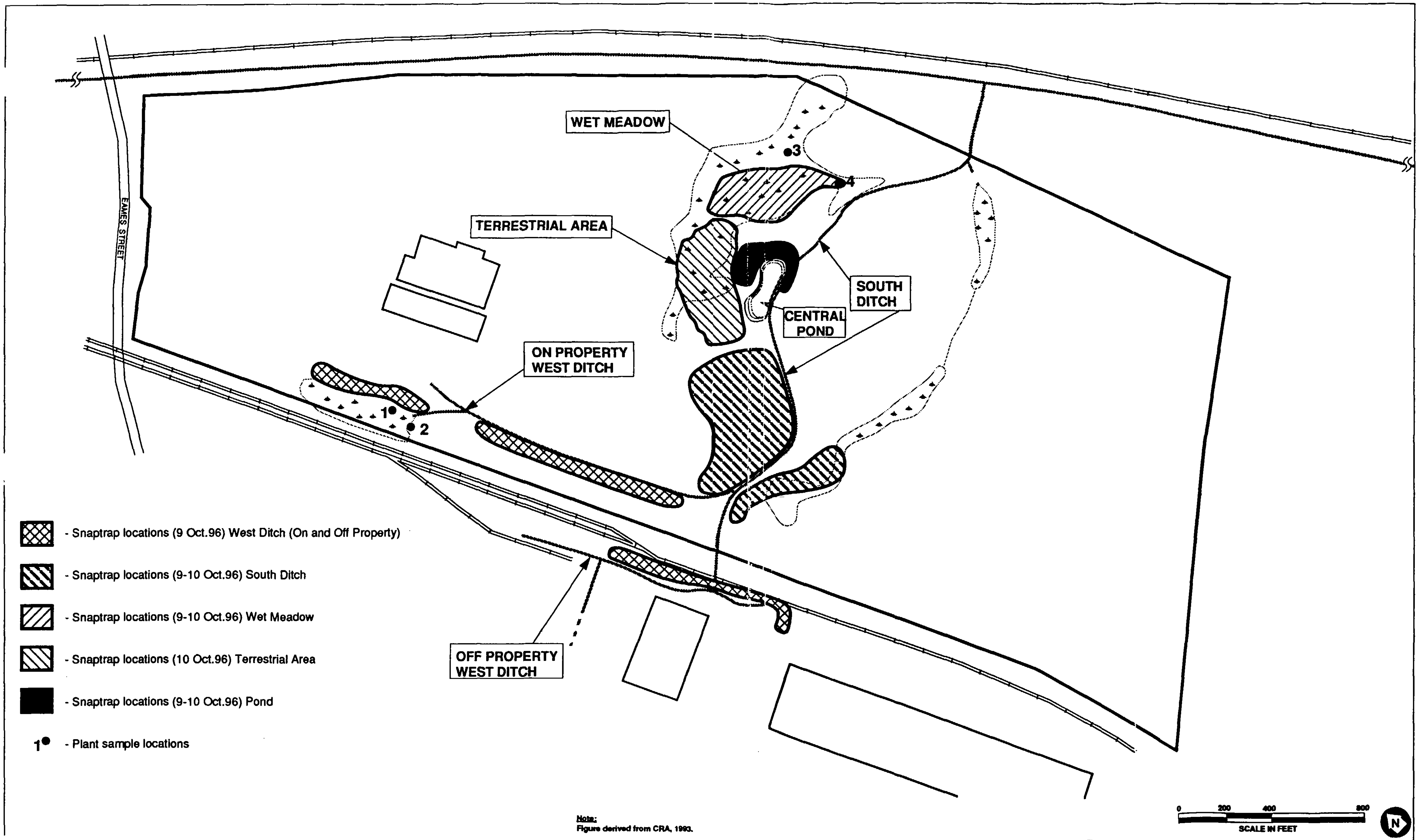


ABB Environmental Services, Inc.
ASEA BROWN BOVERI

FIGURE A1-1
BIOLOGICAL SAMPLE LOCATIONS - SNAP TRAPS
OLIN CORPORATION - WILMINGTON PROPERTY
WILMINGTON, MA

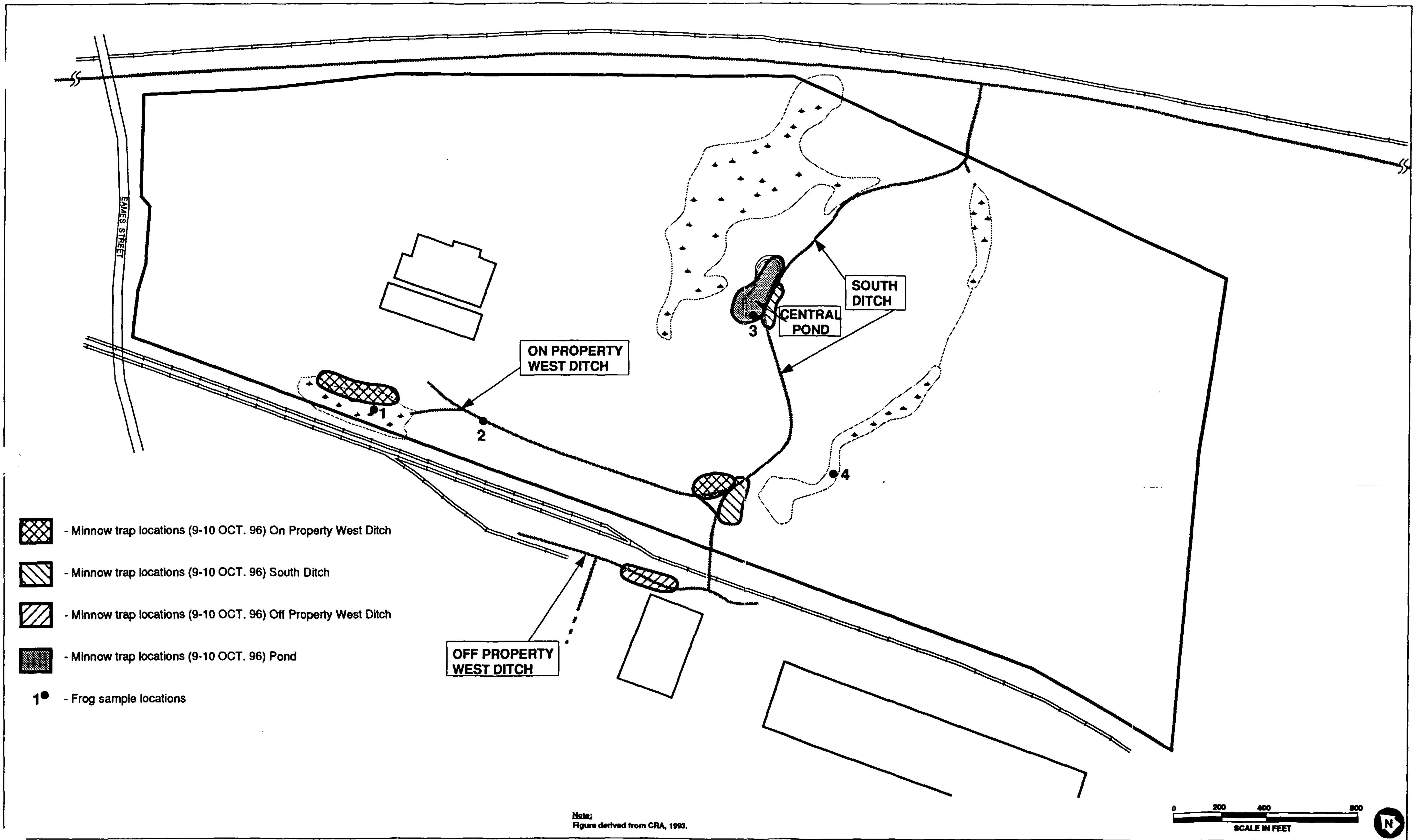


ABB Environmental Services, Inc.

FIGURE A1-2
BIOLOGICAL SAMPLE LOCATIONS - MINNOW TRAPS
OLIN CORPORATION - WILMINGTON PROPERTY
WILMINGTON, MA

ATTACHMENT #2

SAMPLES USED IN ERC

This attachment identifies the analytical data used in the Method 3 Stage II Environmental Risk Characterization for the Olin Corporation Wilmington Facility . This attachment identifies the samples that were included in the analytical data summaries for each data set evaluated in the risk characterization; it does not include the raw analytical data for the identified samples.

Tables A2-1 through A2-5 provide lists of samples for surface soil, surface water, and sediment. The list for each medium is segregated into separate exposure points which are identified with an ecological exposure point number (ECOCPC). For each ECOCPC number, the analytical data for each sample included in that exposure point were used to produce statistical data summaries for the exposure point. The data summaries developed for ECOCPC numbers identified by shading were used to quantitatively evaluate actual exposure points evaluated in the risk characterization; the data summaries developed for ECOCPC numbers lacking shading were used for other purposes, such as OHMPC selection.

TABLE A2-1
SURFACE SOIL SAMPLES USED IN THE ENVIRONMENTAL RISK CHARACTERIZATION

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

SAMPLE LOCATION	SAMPLE NUMBER	MATRIX	DATE SAMPLED	STUDY AREA	ECOCPC NUMBER
AREA 01	1000458	SS	08-Jul-91	A01	50
AREA 1(COMP)	1461488	SS	15-Dec-96	A01	50
AREA 1-1	1461482	SS	15-Dec-96	A01	50
AREA 1-2	1461483	SS	15-Dec-96	A01	50
AREA 1-3	1461484	SS	15-Dec-96	A01	50
AREA 1-4	1461485	SS	15-Dec-96	A01	50
AREA 1-5	1461486	SS	15-Dec-96	A01	50
AREA 1-6	1461487	SS	15-Dec-96	A01	50
BS015SDX	1461527	SS	21-Jan-97	A01	50
BS016SMD	1461528	SS	21-Jan-97	A01	50
SWMU-30	1000469	SS	30-Jul-91	A01	50
SWMU-33	1000470	SS	30-Jul-91	A01	50
AREA 02	1000459	SS	09-Jul-91	A02	51
BS014WDX	1461526	SS	21-Jan-97	A02	51
AREA 03	1000460	SS	09-Jul-91	A03	52
BS013WDX	1461521	SS	21-Jan-97	A03	52
SWMU-27	1000468	SS	30-Jul-91	A03	52
A8CW-1	1461473	SS	16-Dec-96	A08	53
A8CW-2	1461474	SS	16-Dec-96	A08	53
A8CW-3	1461475	SS	16-Dec-96	A08	53
A8CW-4	1461476	SS	16-Dec-96	A08	53
AREA 08	1000465	SS	09-Jul-91	A08	53
AREA8-1	1461469	SS	16-Dec-96	A08	53
AREA8-2	1461470	SS	16-Dec-96	A08	53
AREA8-3	1461471	SS	16-Dec-96	A08	53
AREA8-4	1461472	SS	16-Dec-96	A08	53
BS017PND	1461529	SS	21-Jan-97	A08	53
BS018PND	1461530	SS	21-Jan-97	A08	53
CPDA-1	1461460	SS	16-Dec-96	A08	53
CPDA-2	1461461	SS	16-Dec-96	A08	53
CPDA-3	1461462	SS	16-Dec-96	A08	53
CPDA-4	1461463	SS	16-Dec-96	A08	53
CPDA-5	1461464	SS	16-Dec-96	A08	53
CPDA-6	1461465	SS	16-Dec-96	A08	53
CPDA-7	1461466	SS	16-Dec-96	A08	53
CPDA-8	1461467	SS	16-Dec-96	A08	53
CPDA-9	1461468	SS	16-Dec-96	A08	53

TABLE A2-1
SURFACE SOIL SAMPLES USED IN THE ENVIRONMENTAL RISK CHARACTERIZATION

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

SAMPLE LOCATION	SAMPLE NUMBER	MATRIX	DATE SAMPLED	STUDY AREA	ECOCPC NUMBER
CPDA-9	1461495	SS	16-Dec-96	A08	53
DRMB-(COMP)	1461449	SS	15-Dec-96	A08	53
G1-DRMB	1461445	SS	15-Dec-96	A08	53
G2-DRMB	1461446	SS	15-Dec-96	A08	53
G3-DRMB	1461447	SS	15-Dec-96	A08	53
G4-DRMB	1461448	SS	15-Dec-96	A08	53
A9CW-(COMP)	1461481	SS	16-Dec-96	A09	54
A9CW-1	1461477	SS	16-Dec-96	A09	54
A9CW-2	1461478	SS	16-Dec-96	A09	54
A9CW-3	1461479	SS	16-Dec-96	A09	54
A9CW-4	1461480	SS	16-Dec-96	A09	54
AREA 09	1000466	SS	09-Jul-91	A09	54
BS019WMD	1461531	SS	21-Jan-97	A09	54
BS020WMD	1461532	SS	21-Jan-97	A09	54
AREA 01	1000458	SS	08-Jul-91	ALL	55
AREA 1(COMP)	1461488	SS	15-Dec-96	ALL	55
AREA 1-1	1461482	SS	15-Dec-96	ALL	55
AREA 1-2	1461483	SS	15-Dec-96	ALL	55
AREA 1-3	1461484	SS	15-Dec-96	ALL	55
AREA 1-4	1461485	SS	15-Dec-96	ALL	55
AREA 1-5	1461486	SS	15-Dec-96	ALL	55
AREA 1-6	1461487	SS	15-Dec-96	ALL	55
BS015SDX	1461527	SS	21-Jan-97	ALL	55
BS016SMD	1461528	SS	21-Jan-97	ALL	55
SWMU-30	1000469	SS	30-Jul-91	ALL	55
SWMU-33	1000470	SS	30-Jul-91	ALL	55
AREA 02	1000459	SS	09-Jul-91	ALL	55
BS014WDX	1461526	SS	21-Jan-97	ALL	55
AREA 03	1000460	SS	09-Jul-91	ALL	55
BS013WDX	1461521	SS	21-Jan-97	ALL	55
SWMU-27	1000468	SS	30-Jul-91	ALL	55
A8CW-1	1461473	SS	16-Dec-96	ALL	55
A8CW-2	1461474	SS	16-Dec-96	ALL	55
A8CW-3	1461475	SS	16-Dec-96	ALL	55
A8CW-4	1461476	SS	16-Dec-96	ALL	55
AREA 08	1000465	SS	09-Jul-91	ALL	55
AREA8-1	1461469	SS	16-Dec-96	ALL	55
AREA8-2	1461470	SS	16-Dec-96	ALL	55

TABLE A2-1
SURFACE SOIL SAMPLES USED IN THE ENVIRONMENTAL RISK CHARACTERIZATION

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

SAMPLE LOCATION	SAMPLE NUMBER	MATRIX	DATE SAMPLED	STUDY AREA	ECOCPC NUMBER
AREA8-3	1461471	SS	16-Dec-96	ALL	55
AREA8-4	1461472	SS	16-Dec-96	ALL	55
BS017PND	1461529	SS	21-Jan-97	ALL	55
BS018PND	1461530	SS	21-Jan-97	ALL	55
CPDA-1	1461460	SS	16-Dec-96	ALL	55
CPDA-2	1461461	SS	16-Dec-96	ALL	55
CPDA-3	1461462	SS	16-Dec-96	ALL	55
CPDA-4	1461463	SS	16-Dec-96	ALL	55
CPDA-5	1461464	SS	16-Dec-96	ALL	55
CPDA-6	1461465	SS	16-Dec-96	ALL	55
CPDA-7	1461466	SS	16-Dec-96	ALL	55
CPDA-8	1461467	SS	16-Dec-96	ALL	55
CPDA-9	1461468	SS	16-Dec-96	ALL	55
CPDA-9	1461495	SS	16-Dec-96	ALL	55
DRMB-(COMP)	1461449	SS	15-Dec-96	ALL	55
G1-DRMB	1461445	SS	15-Dec-96	ALL	55
G2-DRMB	1461446	SS	15-Dec-96	ALL	55
G3-DRMB	1461447	SS	15-Dec-96	ALL	55
G4-DRMB	1461448	SS	15-Dec-96	ALL	55
A9CW-(COMP)	1461481	SS	16-Dec-96	ALL	55
A9CW-1	1461477	SS	16-Dec-96	ALL	55
A9CW-2	1461478	SS	16-Dec-96	ALL	55
A9CW-3	1461479	SS	16-Dec-96	ALL	55
A9CW-4	1461480	SS	16-Dec-96	ALL	55
AREA 09	1000466	SS	09-Jul-91	ALL	55
BS019WMD	1461531	SS	21-Jan-97	ALL	55
BS020WMD	1461532	SS	21-Jan-97	ALL	55

Notes:
Surface soil samples - final data set from SMITH (2/27/97). ALL indicates surface soil data from A01, A02, A03, A08, A09 sample grid identifiers, see Figure 3.

TABLE A2-2
SURFACE WATER SAMPLES USED IN THE ENVIRONMENTAL RISK CHARACTERIZATION
(UNFILTERED, HISTORICAL)

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

SAMPLE LOCATION	ABB SAMPLE LOCATION	SAMPLE NUMBER	MATRIX	DATE SAMPLED	STUDY AREA	ECOCPC NUMBER
SW-14	SW-14	1000314	SW	01-Dec-92	offeco	56
SW-15	SW-15	1000318	SW	02-Dec-92	offeco	56
SW-16	SW-16	1000319	SW	02-Dec-92	offeco	56
SW-17	SW-17	1000320	SW	02-Dec-92	offeco	56
SW-18	SW-18	1000321	SW	02-Dec-92	offeco	56
SW-17	SW-17	1000388	SW	02-Dec-92	offeco	56
SW-06	SW-06	1000306	SW	01-Dec-92	southeco	59
SW-07	SW-07	1000307	SW	01-Dec-92	southeco	59
SW-08	SW-08	1000308	SW	01-Dec-92	southeco	59
SW-09	SW-09	1000309	SW	01-Dec-92	southeco	59
SW-10	SW-10	1000310	SW	01-Dec-92	southeco	59
SW-11	SW-11	1000311	SW	01-Dec-92	southeco	59
SW-19	SW-19	1000323	SW	03-Dec-92	southeco	59
SW-06	SW-06	1000387	SW	01-Dec-92	southeco	59
SW-20	SW-20	1000315	SW	01-Dec-92	uneco	61
SW-21	SW-21	1000316	SW	01-Dec-92	uneco	61
SW-22	SW-22	1000317	SW	01-Dec-92	uneco	61
SW-12	SW-12	1000312	SW	01-Dec-92	westeco	58
SW-13	SW-13	1000313	SW	01-Dec-92	westeco	58
SW-14	SW-14	1000314	SW	01-Dec-92	all old	64
SW-15	SW-15	1000318	SW	02-Dec-92	all old	64
SW-16	SW-16	1000319	SW	02-Dec-92	all old	64
SW-17	SW-17	1000320	SW	02-Dec-92	all old	64
SW-18	SW-18	1000321	SW	02-Dec-92	all old	64
SW-17	SW-17	1000388	SW	02-Dec-92	all old	64
SW-06	SW-06	1000306	SW	01-Dec-92	all old	64
SW-07	SW-07	1000307	SW	01-Dec-92	all old	64
SW-08	SW-08	1000308	SW	01-Dec-92	all old	64
SW-09	SW-09	1000309	SW	01-Dec-92	all old	64
SW-10	SW-10	1000310	SW	01-Dec-92	all old	64
SW-11	SW-11	1000311	SW	01-Dec-92	all old	64
SW-19	SW-19	1000323	SW	03-Dec-92	all old	64
SW-06	SW-06	1000387	SW	01-Dec-92	all old	64
SW-20	SW-20	1000315	SW	01-Dec-92	all old	64
SW-21	SW-21	1000316	SW	01-Dec-92	all old	64
SW-22	SW-22	1000317	SW	01-Dec-92	all old	64

TABLE A2-2
SURFACE WATER SAMPLES USED IN THE ENVIRONMENTAL RISK CHARACTERIZATION
(UNFILTERED, HISTORICAL)

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

SAMPLE LOCATION	ABB SAMPLE LOCATION	SAMPLE NUMBER	MATRIX	DATE SAMPLED	STUDY AREA	ECOCPC NUMBER
SW-12	SW-12	1000312	SW	01-Dec-92	all old	64
SW-13	SW-13	1000313	SW	01-Dec-92	all old	64

Notes:
offeco = Off Property West Ditch
pondeco = Central Pond
southeco = South Ditch
uneco = Ephemeral Drainage
westeco = On Property West Ditch
all old = All locations summarized
SW = Surface Water

TABLE A2-3
SURFACE WATER SAMPLES USED IN THE ENVIRONMENTAL RISK CHARACTERIZATION
(UNFILTERED, RECENT)

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

SAMPLE LOCATION	ABB SAMPLE LOCATION	SAMPLE NUMBER	MATRIX	DATE SAMPLED	STUDY AREA	ECOCPC NUMBER
SW-11	SW-15	1460406	SW	03-May-95	offeco	57
SW-12	GSW-12	1460656	SW	18-Oct-95	offeco	57
SW-14	SW-18	1460655	SW	18-Oct-95	offeco	57
SO. DITCH POND	GSW-P	1460824	SW	19-Apr-96	pondeco	63
SW-15	GSW-15	1460405	SW	03-May-95	southeco	60
SW-16	SW-9	1460661	SW	18-Oct-95	southeco	60
SW-17	SW-11	1460659	SW	18-Oct-95	southeco	60
SW-17	SW-11	1460660	SW	18-Oct-95	southeco	60
SW-18	GSW-18	1460415	SW	04-May-95	uneco	62
SW-11	SW-15	1460406	SW	03-May-95	all new	65
SW-12	GSW-12	1460656	SW	18-Oct-95	all new	65
SW-14	SW-18	1460655	SW	18-Oct-95	all new	65
SO. DITCH POND	GSW-P	1460824	SW	19-Apr-96	all new	65
SW-15	GSW-15	1460405	SW	03-May-95	all new	65
SW-16	SW-9	1460661	SW	18-Oct-95	all new	65
SW-17	SW-11	1460659	SW	18-Oct-95	all new	65
SW-17	SW-11	1460660	SW	18-Oct-95	all new	65
SW-18	GSW-18	1460415	SW	04-May-95	all new	65

Notes:
offeco = Off Property West Ditch
pondeco = Central Pond
southeco = South Ditch
uneco = Ephemeral Drainage
westeco = On Property West Ditch
all new = All locations summarized
SW = Surface Water

TABLE A2-4
SURFACE WATER SAMPLES USED IN THE ENVIRONMENTAL RISK CHARACTERIZATION
(FILTERED, RECENT)

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

SAMPLE LOCATION	ABB SAMPLE LOCATION	SAMPLE NUMBER	MATRIX	DATE SAMPLED	STUDY AREA	ECOCPC NUMBER
SW-11	SW-15	1460387	SW	03-May-95	offeco	66
SW-12	GSW-12	1460639	SW	18-Oct-95	offeco	66
SW-14	SW-18	1460638	SW	18-Oct-95	offeco	66
SO. DITCH	GSW-P	1460818	SW	18-Apr-96	pondeco	69
SO. DITCH	GSW-P	1460823	SW	19-Apr-96	pondeco	69
SO. DITCH #1	GSW-1	1460814	SW	18-Apr-96	southeco	67
SO. DITCH #1	GSW-1	1460819	SW	19-Apr-96	southeco	67
SO. DITCH #2	GSW-2	1460815	SW	18-Apr-96	southeco	67
SO. DITCH #2	GSW-2	1460820	SW	19-Apr-96	southeco	67
SO. DITCH #3	GSW-3	1460816	SW	18-Apr-96	southeco	67
SO. DITCH #3	GSW-3	1460821	SW	19-Apr-96	southeco	67
SO. DITCH #4	SW-6	1460817	SW	18-Apr-96	southeco	67
SO. DITCH #4	SW-6	1460822	SW	19-Apr-96	southeco	67
SW-15	GSW-15	1460386	SW	03-May-95	southeco	67
SW-16	SW-9	1460644	SW	18-Oct-95	southeco	67
SW-17	SW-11	1460642	SW	18-Oct-95	southeco	67
SW-17	SW-11	1460643	SW	18-Oct-95	southeco	67
SW-18	GSW-18	1460412	SW	04-May-95	uneco	68
-						
SW-11	SW-15	1460387	SW	03-May-95	all new filt.	70
SW-12	GSW-12	1460639	SW	18-Oct-95	all new filt.	70
SW-14	SW-18	1460638	SW	18-Oct-95	all new filt.	70
SO. DITCH	GSW-P	1460818	SW	18-Apr-96	all new filt.	70
SO. DITCH	GSW-P	1460823	SW	19-Apr-96	all new filt.	70
SO. DITCH #1	GSW-1	1460814	SW	18-Apr-96	all new filt.	70
SO. DITCH #1	GSW-1	1460819	SW	19-Apr-96	all new filt.	70
SO. DITCH #2	GSW-2	1460815	SW	18-Apr-96	all new filt.	70
SO. DITCH #2	GSW-2	1460820	SW	19-Apr-96	all new filt.	70
SO. DITCH #3	GSW-3	1460816	SW	18-Apr-96	all new filt.	70
SO. DITCH #3	GSW-3	1460821	SW	19-Apr-96	all new filt.	70
SO. DITCH #4	SW-6	1460817	SW	18-Apr-96	all new filt.	70
SO. DITCH #4	SW-6	1460822	SW	19-Apr-96	all new filt.	70
SW-15	GSW-15	1460386	SW	03-May-95	all new filt.	70
SW-16	SW-9	1460644	SW	18-Oct-95	all new filt.	70
SW-17	SW-11	1460642	SW	18-Oct-95	all new filt.	70

TABLE A2-4
SURFACE WATER SAMPLES USED IN THE ENVIRONMENTAL RISK CHARACTERIZATION (FILTERED, RECENT)

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

SAMPLE LOCATION	ABB SAMPLE LOCATION	SAMPLE NUMBER	MATRIX	DATE SAMPLED	STUDY AREA	ECOCPC NUMBER
SW-17	SW-11	1460643	SW	18-Oct-95	all new filt.	70
SW-18	GSW-18	1460412	SW	04-May-95	all new filt.	70

Notes:
offeco = Off Property West Ditch
pondeco = Central Pond
southeco = South Ditch
uneco = Ephemeral Drainage
westeco = On Property West Ditch
all new = All locations summarized
SW = Surface Water

TABLE A2-5
SEDIMENT SAMPLES USED IN THE ENVIRONMENTAL RISK CHARACTERIZATION

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

SAMPLE LOCATION	SAMPLE NUMBER	MATRIX	DATE SAMPLED	STUDY AREA	ECOCPC NUMBER
FLOC F#1	1460825	SD	19-Apr-96	floceco	76
FLOC F#2	1460826	SD	19-Apr-96	floceco	76
FLOC F#3	1460827	SD	19-Apr-96	floceco	76
FLOC F#4	1460828	SD	19-Apr-96	floceco	76
FLOC F#5	1460829	SD	19-Apr-96	floceco	76
FLOC RP-2	1460428	SD	03-May-95	floceco	76
FLOC WF-2	1460427	SD	04-May-95	floceco	76
BS007WDO	1461515	SD	20-Jan-97	offeco	71
SW-14	1000354	SD	01-Sep-92	offeco	71
SW-14	1000355	SD	01-Dec-92	offeco	71
SW-15	1000356	SD	02-Sep-92	offeco	71
SW-15	1000357	SD	02-Dec-92	offeco	71
SW-16	1000358	SD	02-Sep-92	offeco	71
SW-16	1000359	SD	02-Dec-92	offeco	71
SW-17	1000360	SD	01-Sep-92	offeco	71
SW-17	1000361	SD	02-Dec-92	offeco	71
SW-17	1000390	SD	01-Sep-92	offeco	71
SW-17	1000391	SD	02-Dec-92	offeco	71
SW-18	1000362	SD	02-Sep-92	offeco	71
SW-18	1000363	SD	02-Dec-92	offeco	71
BS009PND	1461517	SD	20-Jan-97	pondeco	75
BS010PND	1461518	SD	20-Jan-97	pondeco	75
POND	1460672	SD	13-Sep-95	pondeco	75
BS008SD	1461516	SD	20-Jan-97	southeco	73
BS011WMD	1461519	SD	20-Jan-97	southeco	73
SW-06	1000338	SD	31-Aug-92	southeco	73
SW-06	1000339	SD	01-Dec-92	southeco	73
SW-06	1000389	SD	01-Dec-92	southeco	73
SW-07	1000341	SD	01-Dec-92	southeco	73
SW-08	1000342	SD	01-Sep-92	southeco	73
SW-08	1000343	SD	01-Dec-92	southeco	73
SW-09	1000344	SD	01-Sep-92	southeco	73
SW-09	1000345	SD	01-Dec-92	southeco	73
SW-10	1000346	SD	01-Sep-92	southeco	73
SW-10	1000347	SD	01-Dec-92	southeco	73
SW-11	1000348	SD	01-Sep-92	southeco	73
SW-11	1000349	SD	01-Dec-92	southeco	73

TABLE A2-5
SEDIMENT SAMPLES USED IN THE ENVIRONMENTAL RISK CHARACTERIZATION

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

SAMPLE LOCATION	SAMPLE NUMBER	MATRIX	DATE SAMPLED	STUDY AREA	ECOCPC NUMBER
SW-19	1000193	SD	02-Sep-92	southeco	73
SW-19	1000364	SD	03-Dec-92	southeco	73
SW-20	1000185	SD	01-Sep-92	uneco	74
SW-20	1000365	SD	01-Dec-92	uneco	74
SW-21	1000186	SD	01-Sep-92	uneco	74
SW-21	1000366	SD	01-Dec-92	uneco	74
SW-22	1000187	SD	01-Sep-92	uneco	74
SW-22	1000367	SD	01-Dec-92	uneco	74
BS005WDX	1461513	SD	20-Jan-97	westeco	72
BS006WDX	1461514	SD	20-Jan-97	westeco	72
SW-12	1000350	SD	02-Sep-92	westeco	72
SW-12	1000351	SD	01-Dec-92	westeco	72
SW-13	1000352	SD	02-Sep-92	westeco	72
SW-13	1000353	SD	01-Dec-92	westeco	72
BS005WDX	1461513	SD	20-Jan-97	alleco	77
BS006WDX	1461514	SD	20-Jan-97	alleco	77
BS007WDO	1461515	SD	20-Jan-97	alleco	77
BS008SD	1461516	SD	20-Jan-97	alleco	77
BS009PND	1461517	SD	20-Jan-97	alleco	77
BS010PND	1461518	SD	20-Jan-97	alleco	77
BS011WMD	1461519	SD	20-Jan-97	alleco	77
POND	1460672	SD	13-Sep-95	alleco	77
SW-06	1000338	SD	31-Aug-92	alleco	77
SW-06	1000339	SD	01-Dec-92	alleco	77
SW-06	1000389	SD	01-Dec-92	alleco	77
SW-07	1000341	SD	01-Dec-92	alleco	77
SW-08	1000342	SD	01-Sep-92	alleco	77
SW-08	1000343	SD	01-Dec-92	alleco	77
SW-09	1000344	SD	01-Sep-92	alleco	77
SW-09	1000345	SD	01-Dec-92	alleco	77
SW-10	1000346	SD	01-Sep-92	alleco	77
SW-10	1000347	SD	01-Dec-92	alleco	77
SW-11	1000348	SD	01-Sep-92	alleco	77
SW-11	1000349	SD	01-Dec-92	alleco	77
SW-12	1000350	SD	02-Sep-92	alleco	77
SW-12	1000351	SD	01-Dec-92	alleco	77
SW-13	1000352	SD	02-Sep-92	alleco	77
SW-13	1000353	SD	01-Dec-92	alleco	77

TABLE A2-5
SEDIMENT SAMPLES USED IN THE ENVIRONMENTAL RISK CHARACTERIZATION

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

SAMPLE LOCATION	SAMPLE NUMBER	MATRIX	DATE SAMPLED	STUDY AREA	ECOCPC NUMBER
SW-14	1000354	SD	01-Sep-92	alleco	77
SW-14	1000355	SD	01-Dec-92	alleco	77
SW-15	1000356	SD	02-Sep-92	alleco	77
SW-15	1000357	SD	02-Dec-92	alleco	77
SW-16	1000358	SD	02-Sep-92	alleco	77
SW-16	1000359	SD	02-Dec-92	alleco	77
SW-17	1000360	SD	01-Sep-92	alleco	77
SW-17	1000361	SD	02-Dec-92	alleco	77
SW-17	1000390	SD	01-Sep-92	alleco	77
SW-17	1000391	SD	02-Dec-92	alleco	77
SW-18	1000362	SD	02-Sep-92	alleco	77
SW-18	1000363	SD	02-Dec-92	alleco	77
SW-19	1000193	SD	02-Sep-92	alleco	77
SW-19	1000364	SD	03-Dec-92	alleco	77
SW-20	1000185	SD	01-Sep-92	alleco	77
SW-20	1000365	SD	01-Dec-92	alleco	77
SW-21	1000186	SD	01-Sep-92	alleco	77
SW-21	1000366	SD	01-Dec-92	alleco	77
SW-22	1000187	SD	01-Sep-92	alleco	77
SW-22	1000367	SD	01-Dec-92	alleco	77

Final sample list of sediment samples after 1/1/91 based on SMITH 227 database

Notes:
floceco = Floculent (South Ditch)
offeco = Off Property West Ditch
pondeco = Central Pond
southeco = South Ditch
uneco = Ephemeral Drainage
westeco = On Property West Ditch
alleco = All locations summarized
SD = Sediment

ATTACHMENT #3
CHARACTERIZATION OF BACKGROUND CONDITIONS

This attachment presents the background characterization for the Olin Corporation Wilmington, MA Facility. Background analyte concentrations in soil, surface water, and sediment in the area of the site have been characterized. The background sampling locations are shown in Figure 6 for soil, surface water and sediment. Background locations for groundwater are not included in this attachment as they were not used in this ERC. Statistical background summaries and supporting documentation for these media are presented in Tables A3-1 through A3-3. The following paragraphs describe the background sampling and analytical programs for the various media.

The MCP at 310 CMR 40.0835(4)(f) requires a characterization of background concentrations of oil and/or hazardous materials (OHM) at the disposal site. "Background" is defined at 310 CMR 40.0006 as those levels of OHM that would exist in the absence of the disposal site of concern that are: (a) ubiquitous and consistently present in the environment at and in the vicinity of the disposal site of concern; and (b) attributable to geologic or ecological conditions, atmospheric deposition of industrial process or engine emissions, fill materials containing wood or ash, releases to groundwater from a public water supply system and/or petroleum residues that are incidental to the normal operation of motor vehicles.

Soil. Two background soil samples were collected by CRA on November 2, 1992. Samples BGS-01 (surface soil) and BH-41 (subsurface soil) were analyzed for inorganics and semivolatile organic compounds (SVOCs). Five additional soil background samples were collected by ABB-ES on April 22, 1996. Samples SS015XXBKX, SS016XXBKX, SS017XXBKX, SS017XXBKD (duplicate), SS018XXBKX and SS019XXBKX were analyzed for polycyclic aromatic hydrocarbons (PAHs), calcium, potassium, sodium, sulfate, total cyanide, and nitrogen-ammonia as N. Detections in these samples are considered to be representative of background concentrations. Soil background concentrations for other organic compounds are assumed to be non-detectable and the background concentrations for the remaining inorganic parameters are assumed to be equal to the background concentrations presented in Table 2.1 of the MADEP's Guidance for Disposal Site Risk Characterization (MADEP, 1995a). The analytical results and summary statistics for the seven background soil samples are presented in Table A3-

1. In that table, median and maximum concentrations are presented for the analytes for which site-specific background data were collected. The concentrations reported by the MADEP (90th percentile values) are also presented.

Surface Water and Sediment. The MADEP indicates in its guidance for Disposal Site Risk Characterization, Section 9, that it may not be possible to find background conditions in all aquatic environments due to the presence of contaminants from other disposal sites, permitted discharges, and many non-point sources. The MADEP guidance suggests that in an environmental risk characterization, it is appropriate to identify site-related contaminants in aquatic environments by comparing site conditions to "local conditions," which may not meet the MCP definition of background. Local conditions "are levels of OHM present consistently and uniformly throughout the surface water body, or throughout a larger section of river that contains the area potentially affected by contamination at or from the site." It appears that it may be difficult to find surface water and sediment locations around the Wilmington facility that meet the MCP background definition; therefore, it is logical to apply the "local condition" concept to surface water and sediment. The background surface water and sediment sampling program conducted for this site demonstrated that background conditions that strictly meet the MCP definition of background may be difficult to identify.

Two background surface water samples and one background sediment sample were collected by CRA in November, 1992. These samples were collected at sampling locations SW-29 and SW-30. In a March 22, 1995 letter (MADEP, 1995b), the MADEP indicated that the surface water and sediment samples collected at locations SW-29 and SW-30 did not meet the MCP definition of background because it appears the locations of the background samples are being impacted by an "upstream" release. Consequently, these two samples are no longer considered "background" samples, although they may represent local conditions with respect to environmental receptors in the East Ditch area.

ABB-ES collected 15 surface water samples and 15 sediment background samples between April 1 and April 4, 1996. Five surface water samples (SW001XXBKX through SW004XXBKX and SW014XXBKX and its duplicate (SW014XXBKD)) and five sediment samples (SD001XXBKX through SD004XXBKX and SD014XXBKX and its duplicate (SD014XXBKD)) were analyzed for inorganics (method 6010), total solids (sediment only), total organic carbon (sediment only), SVOCs (method 8270B), VOCs and trimethylpentenes (method 8240), and TCL pesticides (method 8080). Four surface water samples (SW001XXBKX through SW004XXBKX) were analyzed for chloride, hardness (as $CaCO_3$), total filterable solids, and sulfate. The remaining surface water samples (SW005XXBKX through SW013XXBKX) and sediment samples (SD005XXBKX through SD013XXBKX) were analyzed for TCL pesticides (method 8080). The analytical results for the background surface water and sediment samples are presented in Tables A3-2 and A3-3, respectively. In those tables, median and maximum concentrations are presented for the analytes for which site-specific background data were collected.

No pesticides or SVOCs were detected in any of the surface water background samples. Those inorganics and metals detected in at least one background surface water sample include aluminum, barium, calcium, chloride, iron, magnesium, manganese, potassium, sodium, sulfate, and zinc. Four VOCs (1,1,1-trichloroethane, tetrachloroethene, toluene and xylene) were each detected in a single background sample. 1,1,1-Trichloroethane (4 J μg/liter) and tetrachloroethene (4 J μg/liter) were detected in SW004XXBKX, while toluene (13 μg/liter) and xylene (19 μg/liter) were detected in SW001XXBKX. A comparison to VOC concentrations in associated blank samples indicates these isolated detections are not laboratory artifacts. These isolated detections of VOCs are unexpected, but these locations are still representative of background conditions for inorganics and metals, as shown by consistency with concentrations at other background surface water sampling locations. The isolated detections of VOCs are consistent with neither the MCP definition of background nor the concept of local conditions (i.e., present consistently and uniformly). Background levels of VOCs in surface water are therefore assumed to be non-detect, despite the isolated detections.

Nineteen inorganics and metals, six pesticides, six SVOCs, and six VOCs were detected in at least one sediment background sample. The pesticides that were detected (4,4'-DDD, 4,4'-DDE, 4,4'-DDT, alpha-chlordane, gamma-chlordane, and dieldrin) are persistent compounds that are routinely detected in sediments that are not impacted by direct sources of OHM (particularly in depositional areas). These compounds and their reported concentrations are considered background conditions. Among the SVOCs detected, bis(2-ethylhexyl)phthalate was found in three of five samples tested. This compound is detected almost ubiquitously in the environment and is also a common laboratory artifact. However, a comparison to associated blanks does not confirm that these detections are laboratory artifacts. The bis(2-ethylhexyl)phthalate is considered a background condition.

In three of five sediment background samples tested, no PAHs were detected. Ten PAHs were detected in SD001XXBKX and four PAHs (all estimated values below the reporting limit) were detected in SD002XXBKX. Concentrations of PAHs in SD001XXBKX appear to be substantially higher than concentrations in the only other sample with detected PAHs. This suggests this sampling location is impacted by some source and therefore is not representative of background conditions for SVOCs. Therefore, the PAH results for this sample were not included in the background data set. PAH concentrations in background sediments are considered to be below the reporting limits reported in the background samples.

Among the VOCs detected in background sediment samples , 1,1,1-trichloroethane, acetone, methylene chloride, and xylene were each detected in two of five samples; tetrachloroethene was detected in four of five samples; and 2-butanone was detected in one of five samples. These compounds are often laboratory artifacts; however, a comparison of detected concentrations to associated blanks does not suggest these VOC detections are laboratory artifacts. The isolated detections of VOCs are consistent with neither the MCP definition of background nor the concept of local conditions (i.e., present consistently and uniformly). Background levels of VOCs in sediment are therefore assumed to be non-detect, despite the isolated detections.

TABLE A3-1
SOIL CONCENTRATIONS AT BACKGROUND SAMPLE LOCATIONS - SUMMARY STATISTICS

Olin Corporation
Wilmington, MA Facility

Analyte	Frequency of Detection	Minimum SQL	Maximum SQL	Mininimum Detected Concentration	Maximum Detected Concentration	Median of all Samples*	MADEP Soil Background Value**
SVOC (ug/Kg)							
Benzo(b)fluoranthene	2 / 7	330	430	58	62	60	NA
Fluoranthene	2 / 7	330	430	47	66	57	NA
Phenanthrene	1 / 7	330	430	43	43	43	NA
Pyrene	2 / 7	330	430	47	65	56	NA
Metals (mg/Kg)							
Aluminum	2 / 2			6100	7900	7000	13000
Antimony	ND						1.4
Arsenic	2 / 2			6.2	7.1	6.7	17
Barium	2 / 2			11	22	17	45
Beryllium	ND						0.4
Cadmium	ND						2
Calcium	7 / 7			125	2000	620	NA
Chromium	2 / 2			14	16	15	29
Cobalt	2 / 2			2.4	3.7	3.1	4.4
Copper	2 / 2			5.1	6.4	5.8	38
Iron	2 / 2			9200	12000	11000	17000
Lead	1 / 2	10	10	11	11	10.5	99
Magnesium	2 / 2			2400	3000	2700	4900
Manganese	2 / 2			100	150	125	300
Mercury	ND						0.3
Nickel	2 / 2			5.5	6.5	6	17
Potassium	7 / 7			120	1400	260	NA
Selenium	ND						0.5
Silver	ND						0.6
Sodium	7 / 7			22.5	130	29	NA
Thallium	ND						0.6
Vanadium	2 / 2			12	16	14	29
Zinc	2 / 2			16	21	19	116
Wet Chemistry (mg/Kg)							
Nitrogen-Ammonia as N	4 / 5	8	8	17	37	26	NA
Sulfate	1 / 5	20	80	30	30	< 40	NA

TABLE A3-1
SOIL BACKGROUND ANALYTICAL RESULTS

Olin Corporation
Wilmington, MA Facility

Analyte	SS015XXBKX WM0747-2 4/22/96	SS016XXBKX WM0747-3 4/22/96	SS017XXBKD WM0747-4 (duplicate) 4/22/96	SS017XXBKX WM0747-1 4/22/96	SS018XXBKX WM0747-6 4/22/96	SS019XXBKX WM0747-7 4/22/96	BGS-01 11/02/92	BH-41 11/02/92
SVOC (ug/Kg)								
Benzo(b)fluoranthene	J 62	< 430	J 58	< 400	< 400	< 360	< 330	< 330
Fluoranthene	J 66	< 430	J 47	< 400	< 400	< 360	< 330	< 330
Phenanthrene	J 43	< 430	< 400	< 400	< 400	< 360	< 330	< 330
Pyrene	J 65	< 430	J 47	< 400	< 400	< 360	< 330	< 330
Metals (mg/Kg)								
Aluminum							7900	6100
Antimony							< 20	< 20
Arsenic							7.1	6.2
Barium							22	11
Beryllium							< 1.5	< 1.5
Cadmium							< 1	< 1
Calcium	2000	270	130	120	250	880	1400	620
Chromium							16	14
Cobalt							3.7	2.4
Copper							6.4	5.1
Iron							12000	9200
Lead							11	< 10
Magnesium							3000	2400
Manganese							150	100
Mercury							< 0.1	< 0.1
Nickel							6.5	5.5
Potassium	290	220	120	120	230	260	1400	910
Selenium							< 0.64	< 0.64
Silver							< 1.5	< 1.5
Sodium	35	29	22	23	26	28	130	39
Thallium							< 0.5	< 0.5
Vanadium							16	12
Zinc							21	16
Wet Chemistry (mg/Kg)								
Nitrogen-Ammonia as N	< 8	37	17	34	31	19		
Sulfate	< 80	< 40	30	< 40	< 20	< 40		

Duplicate samples were averaged with their original samples prior to calculation of statistics.

* For PAHs, the median was determined from detected concentrations only, due to the high reporting limits and low frequencies of detection.

** Background soil concentrations for non-urban locations published by MADEP (1995), which represent the 90th percentile values from the collected data set. These values are presented as background concentrations because site-specific background samples may not be sufficient for conducting statistical analyses. If number of samples is greater than or equal to 5, site-specific background information is used, if available.

ND = Not detected above the reporting limit in any samples.
NA = Not applicable/Not available
ug/L = micrograms per liter
mg/L = milligrams per liter
SQL = Sample quantitation limit

TABLE A3-2
SURFACE WATER CONCENTRATIONS AT BACKGROUND SAMPLE LOCATIONS - SUMMARY STATISTICS

Olin Corporation
Wilmington, MA Facility

Analyte	Frequency of Detection*	Minimum SQL	Maximum SQL	Minimum Detected Concentration	Maximum Detected Concentration	Median of all Samples **
VOC (ug/L)						
1,1,1-Trichloroethane	1 / 5	5	5	4	4	<5
Tetrachloroethene	1 / 5	5	5	4	4	<5
Toluene	1 / 5	5	5	13	13	<5
Xylene	1 / 5	5	5	19	19	<5
Metals (mg/L)						
Aluminum	1 / 5	0.1	0.1	0.37	0.37	<0.1
Barium	5 / 5			0.01	0.034	0.018
Calcium	5 / 5			9.9	28	18
Iron	5 / 5			0.16	1.8	0.235
Magnesium	5 / 5			2.1	3.4	2.7
Manganese	5 / 5			0.01	0.1	0.042
Potassium	5 / 5			1.2	3.3	2.4
Sodium	5 / 5			32	58	44
Zinc	2 / 5	0.025	0.025	0.031	0.048	<0.025
Wet Chemistry (mg/L)						
Chloride	4 / 4			68	110	71
Hardness, CaCO3	4 / 4			35	87	56
Solids - Filterable Residue	4 / 4			150	280	180
Sulfate	4 / 4			19	24	21

Duplicate samples were averaged with their original samples prior to calculation of statistics.
* Nine additional surface water samples (SW005XXBKX through SW013XXBKX) were collected and analyzed for pesticides only; however, no pesticides were detected in these background samples.
** The median represents the median value of all sample results, including non-detects, for which the reporting limit was used as the concentration value for non-detects.
SQL = sample quantitation limit
ug/L = micrograms per liter
mg/L = milligrams per liter

TABLE A3-2
SURFACE WATER BACKGROUND ANALYTICAL RESULTS

Olin Corporation
Wilmington, MA Facility

Analyte	SW001XXBKX WM0593-1 4/1/96	SW002XXBKX WM0593-4 4/1/96	SW003XXBKX WM0625-5 4/3/96	SW004XXBKX WM0625-6 4/3/96	SW014XXBKD WM0640-8 (duplicate) 4/4/96	SW014XXBKX WM0640-7 4/4/96
VOC (ug/L)						
1,1,1-Trichloroethane	< 5	< 5	< 5	J 4	< 5	< 5
Tetrachloroethene	< 5	< 5	< 5	J 4	< 5	< 5
Toluene	13	< 5	< 5	< 5	< 5	< 5
Xylene	19	< 5	< 5	< 5	< 5	< 5
Metals (mg/L)						
Aluminum	< 0.1	0.37	< 0.1	< 0.1	< 0.1	< 0.1
Barium	0.034	0.023	0.01	0.018	0.019	0.018
Calcium	28	18	9.9	15	19	18
Iron	1.8	0.56	0.18	0.16	0.25	0.22
Magnesium	3.4	3	2.1	2.7	2.7	2.6
Manganese	0.099	0.1	0.01	0.01	0.042	0.041
Potassium	3.3	2.4	1.2	2.6	2.1	2
Sodium	58	32	37	44	47	45
Zinc	0.048	< 0.025	< 0.025	< 0.025	0.032	0.03
Wet Chemistry (mg/L)						
Chloride	110	68	74	81		
Hardness, CaCO3	87	62	35	50		
Solids - Filterable Residue	280	190	150	170		
Sulfate	24	22	19	20		

TABLE A3-3
SEDIMENT CONCENTRATIONS AT BACKGROUND SAMPLE LOCATIONS - SUMMARY STATISTICS

Olin Corporation
Wilmington, MA Facility

Analyte	Frequency of Detection	Range of SQLs	Minimum Detected Concentration	Maximum Detected Concentration	Median of all Samples*
VOCs (ug/Kg)					
1,1,1-Trichloroethane	2/5	9 - 15	8.8	19	<14
2-Butanone	1/5	27 - 44	130	130	<42
Acetone	2/5	27 - 44	11	190	<42
Methylene Chloride	2/5	23 - 29	12	13	<23
Tetrachloroethene	4/5	12 - 12	6	25	12
Xylene	2/5	12 - 29	4	9	<12
SVOCs (ug/Kg)					
Benzo(a)Pyrene	1/4	530 - 960	420	420	<668
Benzo(b)fluoranthene	1/4	530 - 790	750	750	572
Chrysene	1/4	530 - 790	510	510	<960
Fluoranthene	1/4	530 - 790	860	860	<668
Pyrene	1/4	530 - 790	750	750	<668
bis(2-ethylhexyl)phthalate	3/5	760 - 960	315	2,000	572
Pesticides (ug/Kg)					
4,4'-DDD	10/14	5 - 9.6	2.8	260	7.6
4,4'-DDE	8/14	5 - 9.6	2.8	460	<8.5
4,4'-DDT	3/14	5 - 12	8.1	31	8.5
Alpha-chlordane	1/14	2.6 - 9.5	5.6	5.6	<4.4
Dieldrin	2/14	2.9 - 18	17	27	<9.2
Gamma-chlordane	1/14	2.6 - 9.5	5.3	5.3	<4.4
Metals (mg/Kg)					
Aluminum	5/5	NR	1,100	12,000	6,300
Arsenic	5/5	NR	6.9	44	8.5
Barium	5/5	NR	8.2	45	32.5
Calcium	5/5	NR	1,300	4,100	2,100
Chromium (VI)	4/5	0.5 - 0.5	0.53	1.2	0.53
Chromium, Total	5/5	NR	11	19.5	13
Cobalt	2/5	4.9 - 7.2	5.1	6.7	6.7
Copper	4/5	5.7 - 5.7	15	33	21
Iron	5/5	NR	4,000	14,000	6,400
Lead	5/5	NR	11	89	26.5
Magnesium	5/5	NR	220	3,200	1,200
Manganese	5/5	NR	55	680	128
Mercury	3/5	0.14 - 0.27	0.27	0.54	0.27

TABLE A3-3
SEDIMENT CONCENTRATIONS AT BACKGROUND SAMPLE LOCATIONS - SUMMARY STATISTICS

Olin Corporation
Wilmington, MA Facility

Analyte	Frequency of Detection	Range of SQLs	Minimum Detected Concentration	Maximum Detected Concentration	Median of all Samples*
Nickel	2/5	7.8 - 9.6	11	15.5	<9.6
Potassium	4/5	100 - 100	270	805	490
Sodium	5/5	NR	70	290	114
Thallium	1/5	2.5 - 3.8	3.6	3.6	<3.4
Vanadium	5/5	NR	8.9	26	16
Zinc	5/5	NR	18	130	61.5
Other (mg/Kg)					
Solids-Total Residue (TS) (wt%)	15/15	NR	18	69	39
Total Organic Carbon	11/11	NA	15,000	380,000	66,000

Duplicate samples were averaged with their original samples prior to calculation of statistics.
PAH data for SD001XXBKX were not included in summary statistics
* The median represents the median value of all sample results, including non-detects, for which the reporting limit was used as the concentration value for non-detects.

SQL = sample quantitation limit
ug/L = micrograms per liter
mg/L = milligrams per liter

TABLE A3-3
SEDIMENT BACKGROUND ANALYTICAL RESULTS

Olin Corporation
Wilmington, MA Facility

Analyte	SD001XXBKR WM0992-1 5/21/96	SD001XXBKX WM0593-2 4/1/96	SD002XXBKX WM0593-5 4/1/96	SD003XXBKX WM0625-7 4/3/96	SD004XXBKX WM0625-8 4/3/96	SD005XXBKX WM0607-2 4/2/96	SD006XXBKX WM0607-3 4/2/96	SD007XXBKX WM0607-4 4/2/96
VOCs (ug/Kg)								
1,1,1-Trichloroethane		19	< 15	< 14	< 12			
2-Butanone		< 35	< 44	< 42	130			
Acetone		JB 11	< 44	< 42	B 190			
Methylene Chloride		< 23	< 29	J 13	< 24			
Tetrachloroethene		25	J 12	J 6	< 12			
Xylene		< 12	J 9	< 14	< 12			
SVOCs (ug/Kg)								
Benzo(a)Pyrene		1800	< 960	< 790	J 420			
Benzo(b)fluoranthene		4100	J 750	< 790	< 790			
Chrysene		2900	J 510	< 790	< 790			
Fluoranthene		4800	J 860	< 790	< 790			
Pyrene		3600	J 750	< 790	< 790			
bis(2-ethylhexyl)phthalate		< 760	< 960	1600	2000			
Pesticides (ug/Kg)								
4,4'-DDD	< 5.6		17	22	J 4.6	< 5	150	7.4
4,4'-DDE	< 5.6		15	17	< 7.9	< 5	47	J 4.4
4,4'-DDT	< 5.6		J 8.1	< 9.2	< 7.9	< 5	< 12	
Alpha-chlordane	< 2.9		5.6	< 4.8	< 4.1	< 2.6	< 6.1	< 3.1
Dieldrin	< 2.9		< 9.6	< 9.2	< 7.9	< 5	< 12	< 5.9
Gamma-chlordane	< 2.9		5.3	< 4.8	< 4.1	< 2.6	< 6.1	< 3.1
Metals (mg/Kg)								
Aluminum		4300	12000	6300	1100			
Arsenic		9.7	8.5	6.9	44			
Barium		16	39	45	8.2			
Calcium		1300	2100	4100	2400			
Chromium (VI)		< .5	.53	.53	1.2			
Chromium, Total		12	16	13	11			
Cobalt		< 5.8	< 7.2	6.7	< 6.8			
Copper		33	21	15	< 5.7			
Iron		5900	14000	6400	4000			
Lead		20	58	89	11			
Magnesium		1200	1000	1700	220			
Manganese		55	680	630	77			
Mercury		.54	.33	.27	< .2			

TABLE A3-3
SEDIMENT BACKGROUND ANALYTICAL RESULTS

Olin Corporation
Wilmington, MA Facility

Analyte	SD001XXBKR WM0992-1 5/21/96	SD001XXBKX WM0593-2 4/1/96	SD002XXBKX WM0593-5 4/1/96	SD003XXBKX WM0625-7 4/3/96	SD004XXBKX WM0625-8 4/3/96	SD005XXBKX WM0607-2 4/2/96	SD006XXBKX WM0607-3 4/2/96	SD007XXBKX WM0607-4 4/2/96
Nickel		< 7.8	< 9.6	11	< 9.1			
Potassium		510	270	490	< 100			
Sodium		110	180	290	70			
Thallium		< 2.9	3.6	< 3.8	< 3.4			
Vanadium		16	15	21	8.9			
Zinc		66	130	59	18			
Other (mg/Kg)								
Solids-Total Residue (TS) %	59	44	35	36	41	68	28	55
Total Organic Carbon	17000	34000	59000	130000	380000	21000	110000	66000

TABLE A3-3
SEDIMENT BACKGROUND ANALYTICAL RESULTS

Olin Corporation
Wilmington, MA Facility

Analyte	SD008XXBKX WM0625-3 4/3/96	SD009XXBKX WM0625-4 4/3/96	SD010XXBKX WM0640-4 4/4/96	SD011XXBKX WM0640-5 4/4/96	SD012XXBKX WM0640-6 4/4/96	SD013XXBKX WM0607-1 4/2/96	SD014XXBKD WM0640-11 (duplicate) 4/4/96	SD014XXBKX WM0640-10 4/4/96
VOCs (ug/Kg)								
1,1,1-Trichloroethane							< 9	J 13
2-Butanone							< 27	< 44
Acetone							< 27	< 44
Methylene Chloride							JB 10	< 29
Tetrachloroethene							14	22
Xylene							J 4	< 15
SVOCs (ug/Kg)								
Benzo(a)Pyrene							< 560	< 530
Benzo(b)fluoranthene							< 560	< 530
Chrysene							< 560	< 530
Fluoranthene							< 560	< 530
Pyrene							< 560	< 530
bis(2-ethylhexyl)phthalate							J 390	J 240
Pesticides (ug/Kg)								
4,4'-DDD	J 2.8	14	J 5.4	< 6.6	21	260	< 5.9	< 9.6
4,4'-DDE	J 2.8	21	< 9.2	< 6.6	J 6.1	460	< 5.9	< 9.6
4,4'-DDT	< 5	< 8.9	< 9.2	< 6.6	< 11	31	< 5.9	< 9.6
Alpha-chlordane	< 2.6	< 4.6	< 4.8	< 3.4	< 5.6	< 9.5	< 3.1	< 4.9
Dieldrin	27	17	< 9.2	< 6.6	< 11	< 18	< 5.9	< 9.6
Gamma-chlordane	< 2.6	< 4.6	< 4.8	< 3.4	< 5.6	< 9.5	< 3.1	< 4.9
Metals (mg/Kg)								
Aluminum							8500	14000
Arsenic							4.8	9.2
Barium							25	40
Calcium							1000	1600
Chromium (VI)							.66	.74
Chromium, Total							15	24
Cobalt							< 4.9	7.8
Copper							17	29
Iron							6800	11000
Lead							20	33
Magnesium							2400	3900
Manganese							97	160
Mercury							< .14	< .27

TABLE A3-3
SEDIMENT BACKGROUND ANALYTICAL RESULTS

Olin Corporation
Wilmington, MA Facility

Analyte	SD008XXBKX WM0625-3 4/3/96	SD009XXBKX WM0625-4 4/3/96	SD010XXBKX WM0640-4 4/4/96	SD011XXBKX WM0640-5 4/4/96	SD012XXBKX WM0640-6 4/4/96	SD013XXBKX WM0607-1 4/2/96	SD014XXBKD WM0640-11 (duplicate) 4/4/96	SD014XXBKX WM0640-10 4/4/96
Nickel							12	19
Potassium							630	980
Sodium							89	140
Thallium							< 2.5	< 3.7
Vanadium							19	32
Zinc							45	78
Other (mg/Kg)								
Solids-Total Residue (TS) %	69	37	36	51	31	18	57	34
Total Organic Carbon	15000	140000				260000		

REFERENCES (ATTACHMENT #3)

Massachusetts Department of Environmental Protection (MADEP), 1995a. "Guidance for Disposal Site Risk Characterization: In Support of the Massachusetts Contingency Plan"; Bureau of Waste Site Cleanup and Office of Research and Standards; July.

Massachusetts Department of Environmental Protection (MADEP), 1995b. Comments on Public Health and Environmental Risk Assessment Submittals, Olin Corporation, 51 Eames Street, Wilmington, DEP RTN: 3-0471, March 22.

ATTACHMENT #4

ECOLOGICAL FOOD WEB MODEL

DESCRIPTION OF ECOLOGICAL FOOD WEB MODEL

No state or federal standards or guidelines are available to evaluate surface soil, sediment, and food chain exposures for terrestrial vertebrate receptors. Therefore, a computer generated food-web model was used to evaluate these exposures. This attachment describes the technical approach used to develop the food web model. In summary, the food web model was used to estimate potential contaminant intakes to each selected ecological receptor species from dietary exposures to food items (e.g., prey items), and incidental exposures to environmental media (e.g, surface water, sediment, and surface soil). The dietary exposure levels calculated in the food-chain model were then combined with toxicity data to develop risk estimates for each of the selected ecological receptors.

Calculation of Intakes

In order to calculate potential contaminant exposures through dietary intakes, the contaminant tissue levels in various primary food items (e.g., prey items such as invertebrates, amphibians, small mammals, and plants) that are consumed by each indicator species were compiled. Potential food items (i.e. invertebrates, amphibians, small mammals, and plants) occuring at the site were collected and analyzed. These measured tissue concentrations were used in the food web model Only site specific tissue concentrations were used in the food web model, no bioaccumulation factors (BAFs) were used in this assessment.

The potential dietary exposure (PDE) level, for each modeled indicator species, is calculated by multiplying each prey species tissue concentration by the proportion of that prey type in the diet, summing these values, adding soil exposure, and multiplying by the Site Foraging Frequency (SFF) of the given receptor species, as shown in the following equation:

$$\boxed{PDE = [(P_1 \times T_1) + (P_2 \times T_2) + \ldots + (P_n \times T_n) + \textit{soil exposure}] \times SFF}$$

where:

PDE	=	Potential dietary exposure (mg/kg)
P_n	=	Percent of diet composed of prey item n
T_n	=	Tissue concentration in prey item n (mg/kg)
Soil Exposure	=	Soil concentration in mg/kg
SFF	=	Site Foraging Frequency; Area of Contaminated Soil (acres)/Home range (acres) (cannot exceed 1)

Detailed information regarding diet, home-range, and other biological exposure parameters used in the food-chain model, for each of the indicator species selected for evaluation, was obtained from the *Wildlife Exposure Factors Handbook* (USEPA, 1993) and other literature sources. The selected exposure parameters are presented in Table A4-1. For calculation of the SFF, the area of contaminated soil or sediment present within a given study area was used.

The potential dietary exposure level for each receptor species was multiplied by the receptor-specific food ingestion rate and divided by the receptor-specific body weight to calculate a Total Body Dose (TBD):

$$\boxed{TBD = PDE\,x\,IR\,x\,\frac{1}{BW}}$$

where:

TBD=	Total Body Dose (mg/kgBW-day)
PDE=	Potential dietary exposure (mg/kg)
IR =	Ingestion rate (kg/day)
BW =	Body weight (kg)

<u>Calculation of Risks</u>

Because the TBD estimates are normalized to the ingestion and body weight of the particular receptor being evaluated, they are directly comparable to Reference Toxicity Values (RTVs) (described in Section 4.2). Combining the TBD estimate with the appropriate RTV results in a quotient (the Hazard Quotient) of potential risk associated with exposure to that particular chemical, as shown in the following equation:

$$\boxed{\frac{TBD}{RTV} = HQ}$$

where:

TBD=	Total Body Dose (mg/kgBw-day)
RTV=	Reference Toxicity Value (mg/kgBW-day)
HQ =	Hazard Quotient (unitless)

The HQ is an expression of the ratio of the estimated total body dose of a particular chemical to the threshold dose upon which the measurement endpoint is based.

Chemical-specific RTVs were selected from the toxicological data set presented in Table A4-2. Because the selected RTVs were generally not derived from toxicity tests using wildlife species that may occur at site, the selected RTVs were modified for differences between toxicity test species and wildlife receptor species body weights via the following equation presented by Opresko (1993):

$$RTV_w = RTV_t \times \left(\frac{BW_t}{BW_w}\right)^{1/3}$$

where:

RTV_w	=	wildlife receptor RTV (value estimated in Table A4-3)
RTV_t	=	test species RTV (value provided in Table A4-2)
BW_w	=	body weight of wildlife receptor (values provided in Table A4-1)
BW_t	=	body weight of test species (values provided in Table A4-2)

This equation is based on a well-founded toxicological generalization that sensitivity is inversely correlated with an organism's metabolic rate, which is often related to detoxification efficiency (Schmidt-Nielsen, 1972). It has been shown that the best measure of differences in body size are those based on body surface area which can be expressed in terms of body weight (bw) raised to the 1/3 power. This scaling function was used to extrapolate equivalent effective doses between animal species that have different metabolic rates (Opresko et al., 1993). The resultant receptor-specific RTVs (Table A4-3) are in mg chemical/kg body weight-day and represent a daily dose of a CPC that is not expected to produce unacceptable adverse effects to the exposed population.

TABLE A4-1
ECOLOGICAL EXPOSURE PARAMETERS FOR REPRESENTATIVE RECEPTOR SPECIES

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

American woodcock -- *Scolopax minor*			
Exposure parameter	Reported values	Reference	Value selected for ecological risk assessment
Home range (acres)	Territory size 0.25 to 100 acres.	DeGraaf and Rudis 1986	50 acres [a]
Exposure duration (unitless)	Summer resident, migrant. Mar.- Nov.	Estimate.	0.75
Diet	50 - 90% earthworms; rest is beetles, flies, insects, and occasionally plants 60% earthworms, 30% insects, 10% plants. Plants vary from 2% of diet in summer to 13% of diet in spring.	DeGraaf and Rudis 1986 Martin et al. 1951	Invertebrates: 85% Plants: 5% Soil: 10% [b]
Ingestion rate (kg/day)	100% body weight/day or more.	~~Terres~~ 1991 USEPA, 1993	~~0.22~~ kg fresh weight/day 0.198
Body weight (kg)	Males average 0.18 kg; females average 0.22 kg.	Terres 1991	0.22 kg
Daily inhalation rate (m^3/day)	Allometric relationship between body weight (BW) and inhalation rate: $IR_{air} = 0.66 * BW(kg)^{0.7579}$	USEPA 1988	0.209 m^3/day
Drinking water intake rate (l/day)	Allometric relationship between body weight (BW) and drinking water rate (L) for all birds: $L = 0.059 * BW(kg)^{0.67}$	Calder and Braun 1983	0.021 l/day

[a] Average of reported values.
[b] Beyer et al. (In press).

TABLE A4-1
ECOLOGICAL EXPOSURE PARAMETERS FOR REPRESENTATIVE RECEPTOR SPECIES

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

Red fox – *Vulpes vulpes*			
Exposure parameter	Reported values	Reference	Value selected for ecological risk assessment
Home range (acres)	< 3 miles in diameter; 142-400 acres. < 5 miles in diameter. 142 to 1280; 900; 1495; 955 acres.	DeGaaf and Rudis 1986 Godin 1977 Baker 1983	250 acres [a]
Exposure duration (unitless)	Active year-round	Estimate.	1.0
Diet	Birds, turtles, frogs, snakes, eggs; snowshoe hare, deer, porcupine, and berries and fruit when available. Small mammals, birds and eggs, insects, earthworms, turtles and eggs, frogs, snakes, wild berries, sarsaparilla, grapes, plums, and apples. Infrequently eats nuts and grains. Mice, rabbits, other small mammals and birds, insects, carrion, fleshy fruits, and seeds. Plants vary from 0% of diet in spring to 3% in winter.	DeGraaf and Rudis 1986 Godin 1977 Martin et al. 1951	Plants: 10% Invertebrates: 20% Amphibians: 15% Small mammals: 42% Birds: 10% Soil: 3%
Ingestion rate (kg/day)	Ingestion rate for free-ranging fox	Sargeant 1978	0.32 kg fresh weight/day
Body weight (kg)	3.6 - 5.4 kg 3.6 - 6.8 kg	Godin 1977 Baker 1983	4.9 kg [b]
Daily inhalation rate (m^3/day)	Allometric relationship between body weight (BW) and inhalation rate: $IR_{air} = 0.66 * BW(kg)^{0.7579}$	USEPA 1988	2.2 m^3/day
Drinking water intake rate (l/day)	Allometric relationship between body weight (BW) and drinking water rate (L) for all mammals: $L = 0.099 * BW(kg)^{0.9}$	Calder and Braun 1983	0.41 l/day

[a] Selected as conservative value. Actual range may be greater.
[b] Average of reported values.

TABLE A4-1
ECOLOGICAL EXPOSURE PARAMETERS FOR REPRESENTATIVE RECEPTOR SPECIES

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

Green heron – *Butorides striatus*			
Exposure parameter	Reported values	Reference	Value selected for ecological risk assessment
Home range (acres)	1.0	Estimate	1 acre
Exposure duration (unitless)	Summer resident, migrant.	Estimate	0.50
Diet	Aquatic and terrestrial insects, fish, amphibians, reptiles, crustaceans	DeGraaf and Rudis 1986	Invertebrates: 50% Amphibians: 45% Sediment: 5%
Ingestion rate (kg/day)	Allometric relationship between body weight (BW) and food ingestion rate (F) for all birds: $F = 0.0582 * BW(kg)^{0.651}$ [a]	Nagy 1987	0.021 kg fresh weight/day
Body weight (kg)	0.212	Palmer 1962	0.212 kg
Daily inhalation rate (m^3/day)	Allometric relationship between body weight (BW) and inhalation rate: $IR_{air} = 0.66 * BW(kg)^{0.7579}$	USEPA 1988	0.204 m^3/day
Drinking water intake rate (l/day)	Allometric relationship between body weight (BW) and drinking water rate (L) for all birds: $L = 0.059 * BW(kg)^{0.67}$	Calder and Braun 1983	0.021 l/day

[a] Value from equation is in dry weight. This was converted to a fresh weight ingestion rate by multiplying water content of each food item in the diet by per cent composition of the food item in the diet, and summing these values (total per cent dietary water content). This value was subtracted from 100% to yield a dry food percentage of the diet. The dry-weight ingestion rate was divided by the dry food percentage to obtain a fresh weight ingestion rate. The following food item water content percentages were used (provided in Suter, 1993):

Table A4-2
Ingestion Toxicity Information for Wildlife

Stage II Ecological Risk Characterization
Olin Corporation
Wilmington, Massachusetts

Chemical	Test Species	Test Type	Duration	Effect	Sublethal RTV mg/kgBW-day LOAEL	Sublethal RTV mg/kgBW-day NOAEL	Reference
VOLATILE ORGANIC COMPOUNDS							
Acetone	Rat	Oral	NR	Reproductive effects	$\boxed{273,000}$		RTECS, 1993
	Rat	Oral LD_{50}	NR	Mortality			RTECS, 1993
	Rat	Oral LD_{50}		Mortality			Sax, 1984
	Mouse	Oral LD_{50}	NR	Mortality			RTECS, 1993
	Rabbit	Oral LD_{50}	NR	Mortality			RTECS, 1993
Benzene	Rat	Single oral dose			76 [b]		TDB, 1984
	Rat	Oral (chronic)	187 days		$\boxed{10}$		USEPA, 1984
2-Butanone	Rat	Oral LD_{50}	NR	Mortality			RTECS, 1994
	Mouse	Oral LD_{50}	NR	Mortality			RTECS, 1994
	Rat	Oral (subchronic)	13 weeks	NOAEL for neurological effects		$\boxed{173}$	ATSDR, 1991a
1,1-Dichloroethylene	Rat	Single oral dose	NR	Mortality			IRIS, 1988
	Rat	Oral (chronic)	2 years	Liver lesions	9		IRIS, 1988
Carbon tetrachloride	Rat	Oral (chronic)	12 weeks		$\boxed{7.1}$		IRIS,1991
	Rat	Single oral dose					Sax, 1984
Chlorobenzene	Rat	Oral (subchronic)	93-99 days		100		USEPA, 1984
	Dog	Oral (subchronic)	13 weeks		$\boxed{136.3}$		IRIS, 1991
	Mouse	Oral (subchronic)	13 weeks		$\boxed{89.3}$		USEPA, 1984
	Rat	Oral (chronic)	2 years	Reproductive effects		$\boxed{30}$	ATSDR, 1992
Chloroform	Rat	Oral	NR	Mortality			RTECS, 1994
	Rat	Oral	NR	Reproductive effects			RTECS, 1994
	Rat	Oral	NR	Reproductive effects			RTECS, 1994
	Mouse	Oral	NR	Reproductive effects			RTECS, 1994
	Mouse	Oral	NR	Reproductive effects			RTECS, 1994
	Guinea pig	Oral	NR	Mortality			RTECS, 1994
	Rabbit	Oral	NR	Reproductive effects			RTECS, 1994
Ethylbenzene	Rat	Oral (subchronic)	182 days	Liver and kidney toxicity	$\boxed{291}$	97.1	IRIS, 1991
	Rat	Oral LD_{50}		Mortality			NIOSH, 1985
	Rat	LD_{50} (gavage)	1 day	Mortality			ATSDR, 1989
2-Hexanone	Rat	Single oral dose			$\boxed{51.8}$ [b]		ATSDR, 1991
Methylene chloride	Rat	Oral LD_{50}	NR	Mortality			RTECS, 1994
	Dog	Oral LD_{50}	NR	Mortality			RTECS, 1994

Table A4-2
Ingestion Toxicity Information for Wildlife

Stage II Ecological Risk Characterization
Olin Corporation
Wilmington, Massachusetts

Chemical	Test Species	Test Type	Duration	Effect	Sublethal RTV mg/kgBW-day LOAEL	NOAEL	Reference
	Rabbit	Oral LD_{50}	NR	Mortality			RTECS, 1994
	Rat	Oral (chronic)	2 years	Liver toxicity	$\boxed{52.6}$	5.9	IRIS,1991
	Rat	Oral (subchronic)	3 months	Mortality, blood chemistry, histopathology		12.5	USEPA, 1984a
Tetrachloroethylene	Rat	Single oral dose		Mortality			NIOSH, 1985
	Mouse	Single oral dose		Mortality			TBD, 1984
	Mouse	Oral (subchronic)	6 weeks	Hepatotoxicity	$\boxed{100}$		Buben and O'Flaherty, 1985
Toluene	Rat	Oral (subchronic)	13 weeks	Increased liver and kidney weight	446		IRIS, 1991
	Rat	Oral LD_{50}		Mortality			NIOSH, 1985
	Mouse	Oral (subchronic)	76 days	Decreased open field activity	$\boxed{76}$		ATSDR, 1992a
1,1,1-Trichloroethane	Ginea Pig	Oral (subchronic)	90 days	Hepatotoxicity	90		IRIS, 1991
	Rat	Single oral dose		Mortality			NIOSH, 1985
	Rat	Oral (subchronic)	78 weeks	Reproductive effects		$\boxed{1500}$	USEPA, 1990
Trichloroethene	Mouse	Single oral dose		Mortality			NIOSH, 1985
	Rat	Single oral dose		Mortality			NIOSH, 1985
Total Xylenes	Rat	Single oral dose					NIOSH, 1985
	Rat	Oral (chronic)	103 weeks		$\boxed{500}$	250	IRIS, 1991
	Japanese quail	Oral (acute)	5 days				Hill and Camardese, 1986
	Mouse	Oral (multi-generati	12 weeks	Decreased dam and fetal weights	$\boxed{750}$		ATSDR, 1991a
SEMIVOLATILE ORGANIC COMPOUNDS							
Acenaphthene	Mouse	Oral (chronic)	90 days	Liver weight increase		175	IRIS, 1990
	Rat	Oral (chronic)	32 days	Physiological changes	2,000		USEPA, 1984a
Acenaphthylene	Rat	Oral (chronic)	40 days		$\boxed{600}$		USEPA, 1984
Anthracene	Mouse	Oral LD_{50}	NR	Mortality			RTECS, 1993
	Rodents	Oral (chronic)	NS	Carcinogenicity	3,300		Eisler, 1987a
	Mouse	Oral (chronic)	90 days	Clinical and pathological effects		1,000	IRIS, 1990
Benzo(a)anthracene	Rodents	Oral (chronic)	NS	Carcinogenicity	2		Eisler, 1987a
Benzo(a)pyrene (surrogate fo	Rat	Oral (chronic)	Pregnancy	Sterility in offspring	40		USEPA, 1984b
Dibenz(a,h)anthracene)	Rat	Oral (chronic)	3.5 months	Reproductive	50		USEPA, 1984b
	Mouse	Oral	Multi-gener	Decreased fertility (F1 progeny and F2 litter size)	$\boxed{10}$ [a]		MacKenzie Angevine, 1981
	Mouse	Oral (subchronic)	6 months	Mortality			ATSDR, 1993b
Benzo(b)fluoranthene and	Rodents	Oral (chronic)	NS	Carcinogenicity	40		Eisler, 1987a

Table A4-2
Ingestion Toxicity Information for Wildlife

Stage II Ecological Risk Characterization
Olin Corporation
Wilmington, Massachusetts

Chemical	Test Species	Test Type	Duration	Effect	Sublethal RTV mg/kgBW-day LOAEL	NOAEL	Reference
Benzo(k)fluoranthene							
Benzo(*g,h,i*)perylene	Rodents	Oral (chronic)	NS	Carcinogenicity	99		Eisler, 1987a
Butylbenzylphthalate	Rat	Oral LD_{50}	NR	Mortality			RTECS, 1994
	Rat	Oral	NR	Reproductive effects	21,000		RTECS, 1994
	Rat	Oral	NR	Reproductive effects	16,400		RTECS, 1994
	Rat	Oral	NR	Reproductive effects	16,400		RTECS, 1994
	Rat	Oral	NR	Reproductive effects	$\boxed{4,900}$		RTECS, 1994
	Mouse	Oral LD_{50}	NR	Mortality			RTECS, 1994
	Guniea Pig	Oral LD_{50}	NR	Mortality			RTECS, 1994
Carbazole	Rat	Oral LD_{50}		Mortality			USEPA, 1986a
Chrysene	Rodents	Oral (chronic)	NS	Carcinogenicity	99		Eisler, 1987a
Dibenzofuran	Rodents	Single oral dose		LC 20			ATSDR, 1991b
	Rodents	Oral (chronic)	13 weeks	LC 10			ATSDR, 1991b
	Mouse	Oral (chronic)	103 weeks	Multinuclear hepatocytes		60	ATSDR, 1991b
1,4-Dichlorobenzene	Rat	LD_{50}, gavage oil	14 days	Mortality			ATSDR, 1992
	Mouse	Oral		Systemic, hepatocellular degeneration	300		ATSDR, 1992
Diethylphthalate (surrogate fo	Mouse	Oral (subchronic)	Multi-gener	Decrease in F1 litter size	$\boxed{3,250}$		ATSDR, 1993c
dimethylphthalate)	Rat	Oral LD_{50}		Mortality			NIOSH, 1985
Di-n-butylphthalate	Rat	Oral (subchronic)	48 days	Reproductive effects	$\boxed{125}$		USEPA, 1989a
	Rat	Oral (chronic)	1 year	Mortality			IRIS, 1991
	Mouse	Oral LD_{50}		Mortality			Sax, 1984
Di-n-octylphthalate	Rat	Oral (chronic)	7-12 months		$\boxed{175}$		USEPA, 1992
	Mouse	Single oral dose					Sax, 1984
	Rat	Oral LD_{50}		Mortality			Sax, 1984
bis(2-Ethylhexyl)phthalate	Rat	Oral LD_{50}	NR	Mortality			RTECS, 1993
	Rat	Oral	NR	Reproductive effects	7,140		RTECS, 1993
	Rat	Oral	NR	Reproductive effects	$\boxed{35}$		RTECS, 1993
	Rat	Oral	NR	Reproductive effects	6,000		RTECS, 1993
	Rat	Oral	NR	Reproductive effects	17,200		RTECS, 1993
	Rat	Oral	NR	Reproductive effects	10,000		RTECS, 1993
	Rat	Oral	NR	Reproductive effects	9,766		RTECS, 1993
	Mouse	Oral LD_{50}	NR	Mortality			RTECS, 1993

Table A4-2
Ingestion Toxicity Information for Wildlife

Stage II Ecological Risk Characterization
Olin Corporation
Wilmington, Massachusetts

Chemical	Test Species	Test Type	Duration	Effect	Sublethal RTV mg/kgBW-day LOAEL	Sublethal RTV mg/kgBW-day NOAEL	Reference
	Mouse	Oral	NR	Reproductive effects	78,880		RTECS, 1993
	Mouse	Oral	NR	Reproductive effects	4,200		RTECS, 1993
	Mouse	Oral	NR	Reproductive effects	50		RTECS, 1993
	Mouse	Oral	NR	Reproductive effects	1,000		RTECS, 1993
	Mouse	Oral	NR	Reproductive effects	2,040		RTECS, 1993
	Rabbit	Oral LD_{50}	NR	Mortality			RTECS, 1993
	Guinea pig	Oral LD_{50}	NR	Mortality			RTECS, 1993
	Guinea pig	Oral	NR	Reproductive effects	20,000		RTECS, 1993
bis(2-Ethylhexyl)phthalate (co	Mammal	Oral	NR	Reproductive effects	20,000		RTECS, 1993
	Mammal	Oral	NR	Reproductive effects	509,000		RTECS, 1993
	Mouse	Oral LD_{50}		Mortality			RTECS, 1993
	Mouse	Oral (subchronic)	13 weeks	Renal effects	125		RTECS, 1993
Fluoranthene	Rat	Oral LD_{50}	NR	Mortality			RTECS, 1994
	Mouse	Oral (subchronic)	90 days	Nephropathy;pathological effects	250	125	IRIS, 1990
Fluorene	Mouse	Oral (chronic)	13 weeks	Hematological changes	250	125	IRIS, 1990
Indeno(1,2,3-cd)pyrene	Rodents	Oral (chronic)	NS	Carcinogenicity	72		Eisler, 1987a
2-Methylnaphthalene	Rat	Oral LD_{50}		Mortality			NIOSH, 1985
Naphthalene	Rat	Oral (chronic)	100 weeks	Ocular lesions	41		USEPA, 1990b
	Rat	Oral (subchronic)	13 weeks	Decreased body weight gain	$\boxed{35.7}$		USEPA, 1990b
N-Nitrosodiphenylamine	Rat	Single oral dose			$\boxed{33}$ [b]		Sax, 1984
	Mouse	Oral LD_{50}		Mortality			ATSDR, 1990a
Phenanthrene	Mouse	Oral LD_{50}	NR	Mortality			RTECS, 1994
	Mouse	Oral (subchronic)	6 months	Increased liver weight	120		ATSDR, 1989c
Phenol	Rat	Oral LD_{50}	NR	Mortality			USEPA, 1980a
	Rat	Oral LD_{50}	NR	Mortality			TDB, 1984
	Rat	Oral LD_{50}	NR	Mortality			USEPA, 1980a
	Rabbit	Oral LD_{50}	NR	Mortality			USEPA, 1980a
	Rabbit	Oral LD_{50}	NR	Mortality			USEPA, 1980a
	Dog	Oral LD_{50}	NR	Mortality			USEPA, 1980a
	Cat	Oral LD_{50}	NR	Mortality			USEPA, 1980a
	Rat	Oral (subchronic)	Gestational	Reduced fetal body weights	$\boxed{120}$		IRIS, 1993

Table A4-2
Ingestion Toxicity Information for Wildlife

Stage II Ecological Risk Characterization
Olin Corporation
Wilmington, Massachusetts

Chemical	Test Species	Test Type	Duration	Effect	Sublethal RTV mg/kgBW-day LOAEL	NOAEL	Reference
Pyrene	Rat	Oral LD_{50}	NR	Mortality			RTECS, 1993 and NIOSH, 1985
	Mouse	Oral LD_{50}	NR	Mortality			RTECS, 1993 and NIOSH, 1985
	Mouse	Oral (chronic)	13 weeks	Renal effects	125	75	IRIS, 1990
1,2,4-Trichlorobenzene	Rat	Oral LD_{50}	NR	Moratlity			Sax, 1984
	Mouse	Oral LD_{50}	NR	Moratlity			Sax, 1984
	Rat	Oral (acute)	NR	Moratlity			Verschueren, 1983
PESTICIDES/PCBs							
alpha-BHC	Rat	Oral (chronic)	56 weeks		$\boxed{2.5}$		ATSDR, 1989
	Mouse	Oral (chronic)	24 wks		32.5		ATSDR, 1989
	Mouse	Oral (chronic)	50 wks		65		ATSDR, 1989
	Rat	Single oral dose					Sax, 1984
Aroclor 1254 (surrogate for Aroclor 1016)	Mouse	Oral	NR	Reproductive	1.53		USEPA, 1993c
	Chicken	Oral (chronic)	NR	Embryonic mortality	0.9		USEPA, 1976
	Rock dove	Oral (chronic)	NR	Parental incubation behavior	$\boxed{0.9}$		Peakall and Peakall, 1973
	American kestr	Oral (chronic)	69 days	Reduced sperm concentration	$\boxed{9}$		Eisler, 1986
	Mink	Oral dose	160 days	Reproductive	0.096		USEPA, 1993c
	Mink	Oral	NR	Kit growth	0.15		USEPA, 1993c
	Mink	Oral	12.5 days	Reproductive	0.375		USEPA, 1993c
	Chicken	Oral	39 weeks	Egg production and fertility	2.44		USEPA, 1993c
	Chicken	Oral	NR	Egg production and hatchability	9.8		USEPA, 1993c
	Chicken	Maternal diet	NR	Chick growth	0.98		USEPA, 1993c
Chlordanes (alpha + gamma)	Mouse	Oral (chronic)	2 years		0.47		ATSDR, 1992
	Rat (male)	Single oral dose					Allen et al., 1979
	Rat (female)	Single oral dose					Allen et al., 1979
	Mouse	Oral (chronic)	30 months		$\boxed{0.273}$	0.055	ATSDR, 1992
	Rabbit	Single oral dose					Allen et al., 1979
	Rabbit	Single oral dose					Allen et al., 1979
	Goat	Single oral dose					Allen et al., 1979
	Cattle	Single oral dose					Allen et al., 1979
	Japanese quail	Oral (acute)	5 days				Hill et al., 1975

Table A4-2
Ingestion Toxicity Information for Wildlife

Stage II Ecological Risk Characterization
Olin Corporation
Wilmington, Massachusetts

Chemical	Test Species	Test Type	Duration	Effect	Sublethal RTV mg/kgBW-day		Reference
					LOAEL	NOAEL	
	Bobwhite	Oral (acute)	5 days				Hill et al., 1975
	Mallard	Oral (acute)	5 days				Hill et al., 1975
	Pheasant	Single oral dose					USFWS, 1984
	Dog	Single oral dose					Allen et al., 1979
	Dog	Single oral dose					Allen et al., 1979
	Dog	Oral (chronic)	2 years		0.375		USEPA, 1988
	Pheasant	Oral	16 weeks	Egg hatchability	1.8		USEPA, 1993c
4,4'-DDE	Rat	Oral LD_{50}	NR	Mortality			RTECS, 1993
	Mouse	Oral LD_{50}	NR	Mortality			RTECS, 1993
	Hamster	Oral LD_{50}	NR	Mortality			RTECS, 1993
	Mallard	Oral	NR	Eggshell thinning	2.91		USEPA, 1993c
	Mallard	Oral	2 years	Reproductive (embryo mortality)	0.58		USEPA, 1993c
	Kestrel	Oral	NR	Eggshell thinning	0.39		USEPA, 1993c
4,4'-DDT (surrogate for 4,4'-	Rat	Oral LD_{50}	NR	Mortality			RTECS, 1993
and 4,4'-DDE)	Rat	Oral LD_{50}		Mortality			USEPA, 1985b
	Rat	Oral	NR	Reproductive	112		RTECS, 1993
	Rat	Oral	NR	Reproductive	100		RTECS, 1993
	Rat	Oral	NR	Reproductive	430		RTECS, 1993
	Rat	Oral	NR	Reproductive	1,890		RTECS, 1993
	Rat	Oral	NR	Reproductive	250		RTECS, 1993
	Rat	Oral	NR	Reproductive	50		RTECS, 1993
	Rat	Oral (chronic)	3 generatio	Reproductive	0.2		IRIS, 1991
	Rat	Oral	2 years	Reproductive	2.5		USEPA, 1993c
	Mouse	Oral LD_{50}	NR	Mortality			RTECS, 1993
	Mouse	Oral LD_{50}		Mortality			USEPA, 1985b
	Mouse	Oral	NR	Reproductive	504		RTECS, 1993
	Mouse	Oral	NR	Reproductive	81		RTECS, 1993
	Mouse	Oral	NR	Reproductive	124		RTECS, 1993
	Mouse	Oral	NR	Reproductive	148		RTECS, 1993
	Rabbit	Oral LD_{50}	NR	Mortality			RTECS, 1993
	Rabbit	Oral	NR	Reproductive	150		RTECS, 1993
	Guinea pig	Oral LD_{50}	NR	Mortality			RTECS, 1993

Table A4-2
Ingestion Toxicity Information for Wildlife

Stage II Ecological Risk Characterization
Olin Corporation
Wilmington, Massachusetts

Chemical	Test Species	Test Type	Duration	Effect	Sublethal RTV mg/kgBW-day LOAEL	NOAEL	Reference
	Hamster	Oral LD_{50}	NR	Mortality			RTECS, 1993
	Dog	Oral LD_{50}	NR	Mortality			RTECS, 1993
	Dog	Oral LD_{50}		Mortality			USEPA, 1985b
	Dog	Oral	NR	Reproductive	$\boxed{3,540}$		RTECS, 1993
	Monkey	Oral LD_{50}	NR	Mortality			RTECS, 1993
	Chicken	Oral (subchronic)	10 weeks	Decreased repro. success; tox. symptoms	91.4 [b]		USEPA, 1985b
	Rock dove	Oral LD_{50}		Mortality			USFWS, 1984
	Black duck	Oral (chronic)	2 years	Reduced eggshell thickness	$\boxed{0.14}$ [b]		Longcore and Stendell, 1977
	Mallard	Oral LD_{50}		Mortality			USFWS, 1984
	Mallard	Oral (subchronic)	96 days	Reduced eggshell thickness	2.8		Longcore and Stendell, 1977
	Mallard	Oral	NR	Eggshell thinning	1.16		USEPA, 1993c
	Mallard	Oral	NR	Eggshell thinning	2.91		USEPA, 1993c
	Mallard	Oral	2 years	Reproductive	1.45		USEPA, 1993c
	California quail	Oral LD_{50}		Mortality			USFWS, 1984
	Japanese quail	Oral LD_{50}		Mortality			USFWS, 1984
	Pheasant	Oral LD_{50}		Mortality			USFWS, 1984
	Sandhill crane	Oral LD_{50}		Mortality			USFWS, 1984
	Kestrel	Oral (chronic)	7 wk - 1 yr	Reduced eggshell thickness	0.56a		USEPA, 1985b
	Kestrel	Oral (chronic)	1 year	Reduced eggshell thickness	0.16a		Wiemeyer, et al., 1986
	Barn owl	Oral (chronic)	2 years	Reduced eggshell thickness	$\boxed{0.14}$ [b]		Longcore and Stendell, 1977
Dieldrin	Mouse	Oral LD_{50}	NR	Mortality			Allen et al., 1979
	Mouse	Oral (chronic)	80 weeks	Body tremors	0.33		NCI, 1978
	Mouse	Oral (chronic)	2 year	Liver enlargement w/ histopathology	0.1		IRIS, 1991
	Mouse	Oral (chronic)	2 year	Hepatic cancer	1.3		ATSDR, 1987
	Rat	Oral (chronic)	2 year	Histologic changes	2		ATSDR, 1987
	Rat	Oral (chronic)	2 year	Liver lesions	0.05	0.005	IRIS, 1991
	Dog	Oral (chronic)	2 year	Increased liver weight; liver/body weight	$\boxed{0.05}$	0.005	IRIS, 1991
	Dog	Oral (chronic)	25 months	Hepatocyte degeneration	0.5		ATSDR, 1987b
	Monkey	Oral (chronic)	120 days	Tremors and convulsions	0.1		Smith et al., 1976

Table A4-2
Ingestion Toxicity Information for Wildlife

Stage II Ecological Risk Characterization
Olin Corporation
Wilmington, Massachusetts

Chemical	Test Species	Test Type	Duration	Effect	Sublethal RTV mg/kgBW-day LOAEL	Sublethal RTV mg/kgBW-day NOAEL	Reference
	Mouse	Oral (subchronic)	4 wks	Decreased pup survival	$\boxed{0.65}$		Virgo and Bellward, 1975
	Rat	Oral (subchronic)	120 days	Operant behavior		0.025	Smith et al., 1976
	Rat	Oral LD_{50}	NR	Mortality			Allen et al., 1979
	Guinea pig	Oral LD_{50}	NR	Mortality			Allen et al., 1979
	Rabbit	Oral LD_{50}	NR	Mortality			Allen et al., 1979
	House sparrow	Oral LD_{50}	NR	Mortality			USFWS, 1984
	Chicken	Oral LD_{50}	NR	Mortality			Allen et al., 1979
	Rock dove	Oral LD_{50}	NR	Mortality			USFWS, 1984
	Gray partridge	Oral LD_{50}	NR	Mortality			USFWS, 1984
	Chukar	Oral LD_{50}	NR	Mortality			USFWS, 1984
	Japanese quail	Oral LD_{50}	5 days	Mortality			Hill et al., 1975
	Japanese quail	Oral LD_{50}	NR	Mortality			USFWS, 1984
	California quail	Oral LD_{50}	NR	Mortality			USFWS, 1984
	Bobwhite	Oral LD_{50}	5 days	Mortality			Hill et al., 1975
	Pheasant	Oral LD_{50}	NR	Mortality			USFWS, 1984
	Mallard	Oral LD_{50}	5 days	Mortality			Hill et al., 1975
	Mallard	Oral LD_{50}	5 days	Mortality			Hill et al., 1975
	Mallard	Oral LD_{50}	NR	Mortality			USFWS, 1984
	Whistling duck	Oral LD_{50}	NR	Mortality			USFWS, 1984
	Canada goose	Oral LD_{50}	NR	Mortality			USFWS, 1984
	Goat	Oral LD_{50}	NR	Mortality			Allen et al., 1979
	Sheep	Oral LD_{50}	NR	Mortality			Allen et al., 1979
	Cattle	Oral LD_{50}	NR	Mortality			Allen et al., 1979
	Mule deer	Oral LD_{50}	NR	Mortality			Allen et al., 1979
	Cat	Oral LD_{50}	NR	Mortality			Allen et al., 1979
	Dog	Oral LD_{50}	NR	Mortality			Allen et al., 1979
Endosulfan (surrogate for	Mouse	Oral (chronic)	78 weeks	Mortality	0.9		ATSDR, 1991

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Stage II Ecological Risk Characterization
Olin Corporation
Wilmington, Massachusetts

Chemical	Test Species	Test Type	Duration	Effect	Sublethal RTV mg/kgBW-day LOAEL	NOAEL	Reference
Endosulfan II and Endosu	Mouse	Oral (chronic)	78 weeks	Ovarian cyst development	$\boxed{0.26}$		ATSDR, 1991
sulfate)	Rat	Single oral dose	NR	Mortality			ATSDR, 1991
	Rat	Oral (chronic)	2 years	Reduced testes weight	10		USEPA, 1980
	Mallard	Single oral dose	NR	Mortality			USFWS, 1984
	Mallard	Single oral dose	NR	Mortality			USFWS, 1984
	Pheasant	Single oral dose	NR	Mortality			USFWS, 1984
Endrin (surrogate for Endrin	Mouse	Oral (chronic)	80 weeks	Mortality	$\boxed{0.53}$		ATSDR, 1990
Endrin aldehyde and Endr	Dog	Oral (chronic)	19 months	Decreased weight gain	$\boxed{0.1}$		USEPA, 1985
Ketone)	Rat	Single oral dose	NR	Mortality			Sax, 1984
	Bird	Single oral dose	NR	Mortality			Sax, 1984
gamma-BHC (Lindane)	Rat	Oral (chronic)	15 weeks			$\boxed{5.0}$	ATSDR, 1992
	Rat	Oral (chronic)	18 weeks			0.33	IRIS, 1991
	Rat	Oral (chronic)	2 years		1.55		IRIS, 1991
	Mouse	Single oral dose	Gestation				ATSDR, 1992
	Bobwhite	Oral (acute)	5 days				Hill et al., 1975
	Mallard	Oral (acute)	5 days				Hill et al., 1975
	Dog	Oral (chronic)	32 weeks			$\boxed{12.5}$	ATSDR, 1988
Heptachlor (used as a surrog	Dog	Oral (chronic)	60 weeks	Increased liver to body weight ratio	0.013		IRIS, 1993
for Heptachlor epoxide)	Rat	Oral (chronic)	2 years	Increased liver to body weight ratio	0.25		IRIS, 1991
	Rat	Oral (chronic)	1 generatio	Increased pup death	$\boxed{0.35}$		IRIS, 1991
	Cat	Oral (chronic)	2 years	Increased liver weight	0.15		USEPA, 1987b
	Rat	Single oral dose	NR	Mortality			Sax, 1984
	Chicken	Single oral dose	NR	Mortality			Sax, 1984
Methoxychlor	Mouse	Single oral dose	NR	Mortality			ATSDR, 1993
	Rat	Oral (acute)	6-20 days	Increased percent dead and early onset of puberty			Khera et al., 1978 and Gray, 1989
	Rat	Oal (chronic)	2 years	Growth retardation	10		USEPA, 1985
	Rat	Oral (chronic)	6 weeks	Decreased litter size	$\boxed{60}$		Harris et al., 1975
INORGANIC ANALYTES							
Aluminum	Mouse	Oral (chronic)	2-3 genrtns	Reduced body weight gain of newborns	$\boxed{425}$		NIOSH, 1985
	Rat	Oral (subchronic)	15 days	Reduced growth	100		Bernuzzi, et al., 1989
	Rat	Oral LD_{50}	NR	Mortality			Sax, 1984
Antimony	Rat	Oral (acute)	Single oral	NOAEL for death			ATSDR, 1991a
	Rat	Oral (chronic)	NS	Longevity; blood glucose; cholesterol	0.35 (water)		IRIS, 1993
	Rat	Oral (subchronic)	24 weeks	Decreased RBC, swelling of hepatic cords	$\boxed{41.8}$		ATSDR, 1991a

Table A4-2
Ingestion Toxicity Information for Wildlife

Stage II Ecological Risk Characterization
Olin Corporation
Wilmington, Massachusetts

Chemical	Test Species	Test Type	Duration	Effect	Sublethal RTV mg/kgBW-day LOAEL	NOAEL	Reference
Arsenic	Rat	Oral	NR	Reproductive effects	0.61		RTECS, 1993
	Rat	Oral	NR	Reproductive effects	0.58		RTECS, 1993
	Rat	Oral LD_{50}	NR	Mortality			RTECS, 1993
	Mouse	Oral LD_{50}	NR	Mortality			RTECS, 1993
	Mallard	Oral LD_{50}	NR	Mortality			Eisler, 1988
	Cowbird	Oral LD_{50}	11 days	Mortality			Eisler, 1988
	Young chicken	Oral	56 days	Egg production		1	Hermeyer et. al., 1977
	Dog	Oral (chronic)	2 years	Mortality			ATSDR, 1991b
Barium	Rat	Oral (chronic)	68 weeks	Renal ultrastructure changes	142		IRIS, 1993
	Rat	Oral (subchronic)	13 weeks	Renal effects	91		Dietz et al., 1992
	Rat	Oral (acute)	10 days	Decreased ovarian weight	198		ATSDR, 1991b
	Rat	Oral (subchronic)	13 weeks	20% population mortality			Dietz et al., 1992
Beryllium	Rat	Oral LD_{50}	NR	Mortality			USEPA, 1985d
	Rat	Oral (chronic)	NR	Increase in lung sacromas	0.22		USEPA, 1985d
	Rat	Oral (chronic)	3.2 years	Respiratory, cardiopulmonary, hematological, a	0.85		ATSDR, 1991e
Cadmium	Rat	Oral	NR	Reproductive effects	155		RTECS, 1993
	Rat	Oral	NR	Reproductive effects	220		RTECS, 1993
	Rat	Oral	NR	Reproductive effects	21.5		RTECS, 1993
	Rat	Oral	NR	Reproductive effects	23		RTECS, 1993
	Rat	Oral LD_{50}		Mortality			Eisler, 1985
	Rat	Oral LD_{50}	NR	Mortality			RTECS, 1993
	Mouse	Oral LD_{50}	NR	Mortality			RTECS, 1993
	Mouse	Oral	NR	Reproductive effects	448		RTECS, 1993
	Mouse	Oral	NR	Reproductive effects	1,700		RTECS, 1993
	Guinea pig	Oral LD_{50}	NR	Mortality			Eisler, 1985
	Mallard	Oral (subchronic)	90 days	Egg production suppressed	10		Eisler, 1985
Chromium	Japanese quail	Oral LD_{50}	5 days	Mortality			Hill and Camardese, 1986
	Rat	Oral (subchronic)	90 days	Histopathologic and reproductive effects		1,400	Ivankovic and Preussman, 1975
	Black Duck	Oral (subchronic)	5 months	Reproductive effects		200	Outridge and Scheuhammer, 1993

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Ingestion Toxicity Information for Wildlife

Stage II Ecological Risk Characterization
Olin Corporation
Wilmington, Massachusetts

Chemical	Test Species	Test Type	Duration	Effect	Sublethal RTV mg/kgBW-day LOAEL	NOAEL	Reference
	Rat	Oral LD_{50}		Mortality			ATSDR, 1991f
Cobalt	Rat	Oral LD_{50}		Mortality			ATSDR, 1991g
	Rat	Single oral dose		Hepatic/renal hyperemia			ATSDR, 1991g
	Rat	Oral (subchronic)	8 weeks	Decreased body weight gain	$\boxed{4.2}$		ATSDR, 1991g
	Rat	Oral (chronic)	98 days	Testicular degeneration	13		ATSDR, 1991g
	Rat	Oral (chronic)	69 days	Testicular atrophy	20		ATSDR, 1991g
	Dog	Oral (subchronic)	4 weeks	Increased red blood cell count	5		ATSDR, 1991g
Copper	Rat	Single oral dose		Reproductive effects	152		NIOSH, 1985 and RTECS, 1993
	Rat	Oral LD_{50}	NR	Mortality			Sax, 1984
	Mouse	Oral (chronic)	30 days	Decreased litter sizes;teratogenic effects	$\boxed{100}$		Lecyk, 1980
Cyanide	Rat	Oral (subchronic)	11.5 month	Incr. thyroid weight, myelin degeneration	30		IRIS, 1993
	Mouse	Single oral dose	NR	Mortality			Arthur D. Little, Inc., 1981
	Young chicken	Oral	20 days	Decreased growth and food intake	$\boxed{11}$		Elzubier and Davis, 1988
	Pig	Oral	110 days	Thyroid hypofunction during pregnancy	11		Tewe and Maner, 1981
	Hamsters	Oral	12 days	Decr. fetal wt. and delayed ossification	$\boxed{11.9}$		Frakes et al., 1986
	Mallard	Single oral dose	NR	Mortality in 6% of population			Eisler, 1991
Lead	Rat	Oral	NR	Reproductive effects	790		RTECS, 1993
	Rat	Oral	NR	Reproductive effects	1,140		RTECS, 1993
	Rat	Oral	NR	Reproductive effects	520		RTECS, 1993
	Rat	Oral	NR	Reproductive effects	1,100		RTECS, 1993
	Calf	Oral LD_{50}	NR	Mortality			Eisler, 1988b
	Rat	Oral (subchronic)	12-14 days	Decreased fetal body weight	$\boxed{2.5}$		McClain and Becker, 1972
	Mouse	Oral	NR	Reproductive effects	1,120		RTECS, 1993
	Mouse	Oral	NR	Reproductive effects	6,300		RTECS, 1993
	Mouse	Oral	NR	Reproductive effects	300		RTECS, 1993
	Mouse	Oral	NR	Reproductive effects	4,800		RTECS, 1993
	Domestic anim	Oral	NR	Reproductive effects	662		RTECS, 1993
	Mammal	Oral	NR	Reproductive effects	2,118		RTECS, 1993
	Kestrel	Diet	NR	Decreased fertility and egg shell thickness		4.61 [b]	Eisler, 1988b
	Kestrel nestling	Oral	10 days	Reduced growth and brain wt.	$\boxed{125}$		Eisler, 1988b
	Japanese quail	Oral LD_{50}	5 days	Mortality			Hill and Camardese, 1986
	Rat	Oral (chronic)	2 generatio	Developmental effects		7	Kimmel et al., 1980 and Grant et al., 1980

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Stage II Ecological Risk Characterization
Olin Corporation
Wilmington, Massachusetts

Chemical	Test Species	Test Type	Duration	Effect	Sublethal RTV mg/kgBW-day LOAEL	NOAEL	Reference
	Guinea pig	Oral LD_{50}		Mortality			Sax, 1984
	Rock dove	Oral (chronic)	NS	Kidney pathology; learning deficiences	6.25		Anders et al., 1982 and Dietz et al., 1979
	Rock dove	Oral LD_{50}		Mortality			Kendall and Scanlon, 1985
Manganese	Mouse	Oral (subchronic)	90 days	Delayed growth of testes	140		ATSDR, 1990c
	Mouse	Oral (chronic)	103 weeks	Mortality	4,050		ATSDR, 1990c
	Rat	Oral LD_{50}	NR	Mortality			ATSDR, 1990c
	Rat	Oral LD_{50}	20 days	Mortality			ATSDR, 1990c
	Rat	Oral (subchronic)	20 days	Decreased litter weight during gestation		620	ATSDR, 1990c
	Rat	Oral (chronic)	103 weeks	Mortality	930		ATSDR, 1990c
	Guinea pig	Oral LD_{50}	NR	Mortality			USEPA, 1984c
	Monkey	Oral (chronic)	18 months	Weakness, rigidity	25		ATSDR, 1990c
	Rodents/livesto	Oral (subchronic)	10 days - 2	Decreased growth rate	$\boxed{100}$		Cunningham et al., 1966
	Mouse	Oral (subchronic)	180 days	NOAEL for mortality			Gianutsos and Murray, 1982
Mercury	Mouse	Oral LD_{50}		Mortality			NIOSH, 1985
	Mouse	Oral (subchronic)	Day 6-17 (g	Stillbirths and neonatal death	4		Suzuki, 1979
	Rat	Oral (subchronic)	Day 6-14 (g	Retarded fetus growth	4		Suzuki, 1979
organomercury	Rat	Oral (chronic)	NR	Reduced fertility	0.5		Eisler, 1987a
	Rat	Oral LD_{50}		Mortality			NIOSH, 1985
organomercury	Pig	Oral (subchronic)	Pregnancy	High incidence of stillbirths	0.5		Eisler, 1987a
organomercury	Mule deer	Oral LD_{50}		Mortality			Eisler, 1987a
organomercury	River otter	Oral LD_{50}		Mortality			Eisler, 1987a
organomercury	Mink	Oral LD_{50}		Mortality			Eisler, 1987a
organomercury	Dog	Oral (subchronic)	Pregnancy	High incidence of stillbirths	$\boxed{0.1}$		Eisler, 1987a
methylmercury	House sparrow	Oral LD_{50}		Mortality			Eisler, 1987a
ethylmercury	Rock dove	Oral LD_{50}		Mortality			Eisler, 1987a
	Chicken	Oral LD_{50}		Mortality			Fimreite, 1979
	Bantam chicke	Oral LD_{50}		Mortality			Fimreite, 1979
ethylmercury	Prairie chicken	Oral LD_{50}		Mortality			Eisler, 1987a
ethylmercury	Chukar	Oral LD_{50}		Mortality			Eisler, 1987a

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Stage II Ecological Risk Characterization
Olin Corporation
Wilmington, Massachusetts

Chemical	Test Species	Test Type	Duration	Effect	Sublethal RTV mg/kgBW-day LOAEL	NOAEL	Reference
methylmercury	Corturnix	Oral LD_{50}		Mortality			Eisler, 1987a
	Mallard	Oral	NR	Reproduction, behavior	$\boxed{0.064}$		USEPA, 1993
methylmercury	Black duck	Oral (subchronic)	28 weeks	Reproduction inhibited	0.22 [a]		Eisler, 1987a
methylmercury	Fulvous whistli	Oral LD_{50}		Mortality			Eisler, 1987a
methylmercury	Northern bobw	Oral LD_{50}		Mortality			Eisler, 1987a
methylmercury	Bobwhite quail	Oral LD_{50}	5 days	Mortality			Hill et al., 1975
	Japanese quail	Oral LD_{50}		Mortality			Eisler, 1987a
ethylmercury	Gray partridge	Oral LD_{50}		Mortality			Eisler, 1987a
organomercury	Gray pheasant	Oral (subchronic)	30 days	Reduced reproductive ability	0.64		Eisler, 1987a
methylmercury	Ring-necked p	Oral LD_{50}		Mortality			Eisler, 1987a
	Mouse	Oral (subchronic)	50 days	Embryotoxicity and teratogenicity	$\boxed{0.9}$		Suzuki, 1979
Nickel	Rat	Oral	NR	Reproductive effects	158		RTECS, 1994
	Rat	Oral LD_{50}	NR	Mortality			USEPA, 1987c
	Rat	Oral (chronic)	2 years	Decreased body weight gain	$\boxed{50}$		USEPA, 1987c
	Rat	Oral LD_{50}	NR	Mortality			Sax, 1984
	Japanese quail	Oral (acute)	5 days	Mortality			Hill and Camardese, 1986
	Dog	Oral (chronic)	2 years	Histological lesions in bone marrow	62.5		USEPA, 1987c
Selenium	Rat	Oral LD_{50}	NR	Mortality			RTECS, 1993
	Rat	Oral LD_{50}	NR	Mortality			Sax, 1984
	Mouse	Oral	NR	Reproductive effects	134		RTECS, 1993
	Mallard	Oral (subchronic)	3 months	Reduced hatchability	$\boxed{1.75}$		Eisler, 1985
	Rat	Oral (chronic)	2 years	Decrease in breeding	$\boxed{0.2}$		ATSDR, 1988
	Rat	Oral (chronic)	NS	Histological changes in heart and kidney	0.045		Eisler, 1985
	Japanese quail	Oral (chronic)	NS	Reduced egg hatching	$\boxed{0.6}$		Eisler, 1985
	Mallard	Oral (subchronic)	3 months	NOAEL for tratogenic effects	0.72	0.36	Eisler, 1985
	Horse	Oral LD_{50}		MLD			Eisler, 1985
	Mallard	Oral	6 weeks	Increased mortality			Heinz et al., 1988
	Black-crowned	Oral	NR	NOAEL for egg hatchability		0.61 [a]	Smith et al., 1988
Vanadium	Japanese quail	Oral LD_{50}	5 days	Mortality			Hill & Camardese, 1986
	Mouse	Gavage LD_{50}	One time	Mortality			ATSDR, 1990d
	Rat	Oral (subchronic)	2 months	Hypertension	15		Susic & Kentera, 1986

Table A4-2
Ingestion Toxicity Information for Wildlife

Stage II Ecological Risk Characterization
Olin Corporation
Wilmington, Massachusetts

Chemical	Test Species	Test Type	Duration	Effect	Sublethal RTV mg/kgBW-day LOAEL	Sublethal RTV mg/kgBW-day NOAEL	Reference
	Rat	Oral (subchronic)	35 days	Development effects		$\boxed{8.4}$	Domingo, et al., 1986
	Chicken	Oral (subchronic)	6 weeks	Decrease in egg-laying	$\boxed{11}$ [c]		Berg et al., 1963
Zinc	Rat	Oral LD_{50}		Mortality			RTECS, 1993
	Rat	Oral	Gestation	Fetal resorptions in 4 to 20% of population	$\boxed{200}$		Shlicker and Cox, 1968
	Ferret	Oral	3-13 days	Mortality and gastrointestinal effects			Straube et al., 1980
	Rat	Oral (subchronic)	NR	Kidney toxicity	160		Llobet, et al., 1988

Notes:

LD_{50} = Dose resulting in 50% mortality in tes LOAEL = Lowest Observed Adverse Effect Level

BW = Body weight NR = Not reported

[a] Value for benzo(a)pyrene chosen as a surrogate for all PAHs. Chemical-specific toxicity studies for ecologically significant endpoints are lacking for other PAHs.

[b] Converted to dose per kilogram body weight by multiplying by ingestion and dividing by body weight. Body weights for birds obtained from Dunning, 1984.
Ingestion rates were calculated using the following regression equation (for all birds) from USEPA, 1993b: Food Ingestion (kg/day) = 0.00582 * Body Weight $^{0.651}$ (kg).
Ingestion rates for the chicken from NRC, 1984 (pg. 13).

[c] Converted from 30 ppm to 11 mg/kgBW-day using standard default parameters (USEPA, 1988b).

[d] Doses converted from pg/gBW/day to mg/kgBW/day

TABLE A4-3
SUMMARY OF REFERENCE TOXICITY VALUES DEVELOPED FOR WILDLIFE RECEPTORS

STAGE II ECOLOGICAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

	American woodcock [a]	Green Heron [a]	Red Fox [a]
Analyte	Sublethal	Sublethal	Sublethal
Volatiles			
1,1,1-Trichloroethane	147.9	145.0	50.8
1,2-Dichloroethene (total)	10.9	10.7	3.7
2-Butanone	209.2	205.1	71.8
2-Hexanone	62.6	61.4	21.5
Acetone	604.6	592.8	207.5
Benzene	12.1	11.9	4.1
Bromoform	27.8	27.3	9.5
Carbon tetrachloride	8.6	8.4	2.9
Chlorobenzene	47.6	46.7	187.2
Chloroform	53.3	52.3	18.3
Ethylbenzene	351.9	345.0	120.7
Methylene chloride	63.6	62.4	21.8
Tetrachloroethene	53.3	52.3	18.3
Toluene	539.3	528.8	185.1
1,2,4-trichlorobenzene	24.2	23.7	8.3
Trichloroethene	25.6	25.1	8.8
Total Xylenes	604.6	592.8	207.5
Semi-volatiles			
2-Methylnaphthalene	39.9	39.1	13.7
Acenaphthene	186.6	183.0	64.0
Acenaphthylene	725.5	711.4	248.9
Anthracene	533.1	522.8	182.9
Benzo(a)anthracene	2.2	2.1	0.7
Benzo(a)pyrene	4.8	4.7	1.7
Benzo(b and k)fluoranthene	43.2	42.4	14.8
Benzo(g,h,i)perylene	107.0	104.9	36.7
Bis(2-ethylhexyl)phthalate	31.2	30.6	10.7
Butylbenzylphthalate	192.2	188.5	2552.2
Carbazole	12.1	11.9	4.1
Chrysene	107.0	104.9	36.7
Dibenzofuran	135.1	132.5	46.4
Dibenz(a,h)anthracene	4.8	4.7	1.7
Diethylphthalate	3820.8	3746.6	1311.1
Di-n-butylphthalate	151.1	148.2	51.9
Di-n-octylphthalate	211.6	207.5	72.6
Fluoranthene	133.3	130.7	45.7
Fluorene	133.3	130.7	45.7
Indeno(1,2,3-cd)pyrene	77.8	76.3	26.7
Naphthalene	43.5	42.7	14.9
N-Nitrosodiphenylamine	39.9	39.1	13.7
Phenanthrene	145.1	142.3	49.8
Phenol	145.1	142.3	49.8
Pyrene	66.6	65.3	22.9
Pesticides			
4,4'-DDD	0.26	0.18	0.08
4,4'-DDE	0.26	0.18	0.08
4,4'-DDT	0.26	0.18	0.08

TABLE A4-3
SUMMARY OF REFERENCE TOXICITY VALUES DEVELOPED FOR WILDLIFE RECEPTORS

STAGE II ECOLOGICAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

Analyte		American woodcock [a]	Green Heron [a]	Red Fox [a]
		Sublethal	Sublethal	Sublethal
Aldrin	[b]	0.35	0.34	0.07
Aroclor-1018	[c]	8.70	8.53	0.05
alpha-BHC		3.02	2.96	1.04
gamma-BHC (Lindane)		6.05	5.93	17.17
alpha-Chlordane		0.15	0.14	0.52
gamma-Chlordane		0.15	0.14	0.52
Dieldrin		0.35	0.34	0.07
Endosulfan I		0.14	0.14	0.05
Endosulfan II		0.14	0.14	0.05
Endosulfan sulfate		0.14	0.14	0.05
Endrin		0.28	0.28	0.14
Endrin Aldehyde		0.28	0.28	0.14
Endrin Ketone		0.28	0.28	0.14
Heptachlor		0.42	0.41	0.02
Heptachlor Epoxide		0.42	0.41	0.02
Methoxychlor		72.5	71.1	24.9
Inorganics				
Aluminum		226.6	222.2	77.7
Antimony		50.5	49.6	17.3
Arsenic		9.1	8.9	20.7
Barium		110.0	107.9	125.0
Beryllium		1.0	1.0	0.4
Cadmium		6.8	6.6	1.0
Chromium		369.6	362.5	580.9
Cobalt		15.7	15.4	5.4
Copper		53.3	52.3	18.3
Cyanide		7.8	7.6	34.4
Lead		8.7	8.6	2.9
Manganese		120.9	118.6	41.5
Mercury		0.4	0.4	0.1
Nickel		8.9	8.7	85.9
Selenium		1.3	1.3	0.1
Thallium		2.3	2.3	0.8
Vanadium		19.8	19.4	6.2
Zinc		241.8	237.1	83.0

NOTES:
All units in mg/kg BW/day
[a] Chemical-specific RTVs are presented in Table A4-2; RTVs adjusted to receptor-specific body weights as described in text.
[b] Value for dieldrin used as surrogate.
[c] Value for Aroclor-1254 used as surrogate.

TABLE A4-4
ESTIMATION OF CHRONIC EXPOSURES TO TERRESTRIAL ORGANISMS VIA FOOD CONSUMPTION AND SURFACE SOIL INGESTION

TERRESTRIAL HABITAT
STAGE II ECOLOGICAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON MASSACHUSETTS

EXPOSURE CONCENTRATION DATA / TISSUE LEVELS IN PRIMARY PREY ITEMS (Site Specific)

CHEMICAL	EPC SOIL (mg/kg)	Invertebrate Tissue Level (mg/kg)	Plant Tissue Level (mg/kg)	Amphibian Tissue Level (mg/kg)	Mammal Tissue Level (mg/kg)	Small Bird Tissue Level (mg/kg) [a]
1,1,1-Trichloroethane	1.4E-02	NA	NA	NA	NA	NA
1,1-Dichloroethene	1.2E-03	NA	NA	NA	NA	NA
2,4,4-Trimethyl-1-pentene	1.3E-03	NA	NA	NA	NA	NA
Acetone	1.9E-02	NA	NA	NA	NA	NA
Methylene Chloride	7.7E-03	NA	NA	NA	NA	NA
Tetrachloroethene (PCE)	2.8E-03	NA	NA	NA	NA	NA
Toluene	3.8E-03	NA	NA	NA	NA	NA
2-Methylnaphthalene	8.4E+00	ND	ND	ND	ND	ND
Acenaphthene	2.6E+00	ND	ND	ND	ND	ND
Acenaphthylene	6.3E+00	ND	ND	ND	ND	ND
Anthracene	4.4E+00	ND	ND	ND	ND	ND
Benzo(a)Anthracene	2.2E+00	ND	ND	ND	ND	ND
Benzo(a)Pyrene	1.6E+00	ND	ND	ND	ND	ND
Benzo(b)Fluoranthene	8.2E-01	ND	ND	ND	ND	ND
Benzo(g,h,i)Perylene	5.5E-01	ND	ND	ND	ND	ND
Benzo(k)Fluoranthene	1.1E+00	ND	ND	ND	ND	ND
Benzoic Acid	6.9E-01	8.3E-01	ND	ND	ND	ND
Butylbenzylphthalate	3.2E-01	ND	ND	ND	ND	ND
Chrysene	2.4E+00	ND	ND	ND	ND	ND
Di-n-butylphthalate	7.5E-01	3.8E-02	ND	ND	ND	ND
Di-n-octylphthalate	1.8E-01	ND	ND	ND	ND	ND
Dibenzofuran	7.0E-01	ND	ND	ND	ND	ND
Diethylphthalate	4.2E-02	ND	ND	ND	ND	ND
Fluoranthene	6.2E+00	ND	ND	ND	ND	ND
Fluorene	6.5E+00	ND	ND	ND	ND	ND
Indeno (1,2,3-cd)Pyrene	4.9E-01	ND	ND	ND	ND	ND
N-Nitrosodiphenylamine (1)	1.3E+00	9.3E-02	ND	ND	ND	ND
Naphthalene	8.3E+00	ND	ND	ND	ND	ND
Phenanthrene	1.6E+01	ND	ND	ND	ND	ND
Phenol	7.4E-01	ND	ND	ND	2.6E-01	2.6E-01
Pyrene	5.1E+00	ND	ND	ND	ND	ND
bis(2-EthylHexyl)phthalate	1.4E+02	7.3E-01	ND	1.2E+01	5.1E+00	5.1E+00
4,4'-DDD	1.5E-03	3.4E-03	ND	2.0E-03	ND	ND
4,4'-DDE	3.1E-03	3.9E-03	ND	1.9E-03	2.4E-03	2.4E-03
4,4'-DDT	7.0E-02	5.6E-03	ND	3.7E-03	2.0E-03	2.0E-03
Aldrin	9.6E-04	ND	ND	1.2E-03	ND	ND
Alpha-BHC	7.0E-03	1.9E-03	9.0E-04	9.0E-04	ND	ND
Alpha-Chlordane	2.9E-03	ND	9.0E-04	1.3E-03	ND	ND
Dieldrin	1.8E-03	2.0E-03	ND	ND	1.7E-03	1.7E-03
Endosulfan I	2.7E-03	ND	ND	ND	ND	ND
Endosulfan II	1.9E-02	ND	ND	2.0E-03	ND	ND
Gamma-BHC (Lindane)	5.5E-03	1.4E-02	1.0E-03	1.0E-03	ND	ND
Gamma-Chlordane	1.8E-03	ND	ND	ND	ND	ND
Heptachlor Epoxide	1.7E-04	ND	ND	1.2E-03	1.3E-03	1.3E-03
PCB-1016	8.7E-02	ND	ND	ND	ND	ND
Aluminum	6.6E+03	4.7E+02	7.2E+01	9.8E+01	5.2E+00	5.2E+00
Antimony	7.5E+00	ND	ND	1.8E-01	1.6E-01	1.6E-01
Arsenic	7.1E+00	1.4E+00	ND	1.6E-01	1.2E-01	1.2E-01
Barium	1.6E+01	2.2E+00	1.9E+00	2.1E+00	1.7E+00	1.7E+00
Beryllium	2.1E-01	ND	ND	1.1E-02	ND	ND
Cadmium	2.5E-01	3.7E+00	2.6E-02	1.6E-01	3.9E-02	3.9E-02
Chromium	5.2E+02	2.6E+01	2.5E+00	3.2E+01	4.2E-01	4.2E-01

TABLE A4-4
ESTIMATION OF CHRONIC EXPOSURES TO TERRESTRIAL ORGANISMS VIA FOOD CONSUMPTION AND SURFACE SOIL INGESTION

TERRESTRIAL HABITAT
STAGE II ECOLOGICAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON MASSACHUSETTS

EXPOSURE CONCENTRATION DATA / **TISSUE LEVELS IN PRIMARY PREY ITEMS (Site Specific)**

CHEMICAL	EPC SOIL (mg/kg)	Invertebrate Tissue Level (mg/kg)	Plant Tissue Level (mg/kg)	Amphibian Tissue Level (mg/kg)	Mammal Tissue Level (mg/kg)	Small Bird Tissue Level (mg/kg) [a]
Cobalt	3.1E+00	2.1E+00	1.2E-01	1.0E-01	4.0E-02	4.0E-02
Copper	9.0E+00	1.6E+00	1.6E+00	2.7E+00	3.3E+00	3.3E+00
Cyanide	9.6E-01	NA	NA	NA	NA	NA
Lead	3.9E+01	2.7E+00	4.1E-01	2.3E-01	1.9E-01	1.9E-01
Manganese	5.0E+01	3.6E+00	4.7E+01	1.2E+01	7.9E+00	7.9E+00
Mercury	2.9E-01	4.0E-01	6.0E-03	3.6E-02	8.1E-03	8.1E-03
Nickel	6.4E+00	7.0E-01	3.7E-01	1.2E-01	2.8E-01	2.8E-01
Selenium	5.2E-01	2.9E+00	1.7E-01	3.4E-01	6.0E-01	6.0E-01
Thallium	6.8E-01	ND	1.6E-01	ND	1.1E-01	1.1E-01
Vanadium	1.5E+01	1.2E+00	2.4E-01	2.2E-01	2.0E-01	2.0E-01
Zinc	2.7E+01	9.3E+01	1.5E+01	2.1E+01	2.8E+01	2.8E+01
Chloride	1.2E+02	NA	NA	NA	NA	NA
Nitrogen, Ammonia	1.6E+02	NA	NA	NA	NA	NA
Sulfate as SO4	2.5E+03	NA	NA	NA	NA	NA

[a] Site-specific small mammal tissue concentrations were used for small birds; and a presented in Attachment 1, Table A1-1.

NA = Not Analysed

ND = Not Detected

TABLE A4-4
RISK ESTIMATION OF SUBLETHAL EFFECTS TO TERRESTRIAL ORGANISMS FROM FOOD CONSUMPTION AND SURFACE SOIL I

TERRESTRIAL HABITAT
STAGE II ECOLOGICAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON MASSACHUSETTS

CHEMICAL	American Woodcock			Red Fox		
	TBD	RTV	HQ	TBD	RTV	HQ
1,1,1-Trichloroethane	2.6E-04	1.5E+02	1.7E-06	1.2E-06	5.1E+01	2.4E-08
1,1-Dichloroethene	2.1E-05	1.1E+01	1.9E-06	9.8E-08	3.7E+00	2.6E-08
2,4,4-Trimethyl-1-pentene	2.4E-05	NA	NA	1.1E-07	NA	NA
Acetone	3.3E-04	6.0E+02	5.5E-07	1.6E-06	2.1E+02	7.6E-09
Methylene Chloride	1.4E-04	6.4E+01	2.1E-06	6.5E-07	2.2E+01	3.0E-08
Tetrachloroethene (PCE)	5.0E-05	5.3E+01	9.4E-07	2.4E-07	1.8E+01	1.3E-08
Toluene	6.8E-05	5.4E+02	1.3E-07	3.2E-07	1.9E+02	1.8E-09
2-Methylnaphthalene	1.5E-01	4.0E+01	3.8E-03	7.1E-04	1.4E+01	5.2E-05
Acenaphthene	4.7E-02	1.9E+02	2.5E-04	2.2E-04	6.4E+01	3.5E-06
Acenaphthylene	1.1E-01	7.3E+02	1.6E-04	5.4E-04	2.5E+02	2.2E-06
Anthracene	7.8E-02	5.3E+02	1.5E-04	3.7E-04	1.8E+02	2.0E-06
Benzo(a)Anthracene	4.0E-02	2.2E+00	1.8E-02	1.9E-04	7.4E-01	2.5E-04
Benzo(a)Pyrene	2.9E-02	4.8E+00	6.0E-03	1.4E-04	1.7E+00	8.3E-05
Benzo(b)Fluoranthene	1.5E-02	4.3E+01	3.4E-04	7.0E-05	1.5E+01	4.7E-06
Benzo(g,h,i)Perylene	9.7E-03	1.1E+02	9.1E-05	4.6E-05	3.7E+01	1.3E-06
Benzo(k)Fluoranthene	2.0E-02	4.3E+01	4.6E-04	9.4E-05	1.5E+01	6.3E-06
Benzoic Acid	1.4E-01	NA	NA	5.3E-04	NA	NA
Butylbenzylphthalate	5.8E-03	1.9E+02	3.0E-05	2.7E-05	2.6E+03	1.1E-08
Chrysene	4.3E-02	1.1E+02	4.0E-04	2.0E-04	3.7E+01	5.5E-06
Di-n-butylphthalate	1.9E-02	1.5E+02	1.3E-04	8.5E-05	5.2E+01	1.6E-06
Di-n-octylphthalate	3.2E-03	2.1E+02	1.5E-05	1.5E-05	7.3E+01	2.1E-07
Dibenzofuran	1.2E-02	1.4E+02	9.2E-05	5.9E-05	4.6E+01	1.3E-06
Diethylphthalate	7.5E-04	3.8E+03	2.0E-07	3.6E-06	1.3E+03	2.7E-09
Fluoranthene	1.1E-01	1.3E+02	8.3E-04	5.3E-04	4.6E+01	1.2E-05
Fluorene	1.2E-01	1.3E+02	8.7E-04	5.5E-04	4.6E+01	1.2E-05
Indeno (1,2,3-cd)Pyrene	8.7E-03	7.8E+01	1.1E-04	4.1E-05	2.7E+01	1.6E-06
N-Nitrosodiphenylamine (1)	3.7E-02	4.0E+01	9.3E-04	1.6E-04	1.4E+01	1.2E-05
Naphthalene	1.5E-01	4.4E+01	3.4E-03	7.1E-04	1.5E+01	4.7E-05
Phenanthrene	2.8E-01	1.5E+02	1.9E-03	1.3E-03	5.0E+01	2.7E-05
Phenol	1.3E-02	1.5E+02	9.2E-05	4.5E-04	5.0E+01	8.9E-06
Pyrene	9.1E-02	6.7E+01	1.4E-03	4.3E-04	2.3E+01	1.9E-05
bis(2-EthylHexyl)phthalate	2.7E+00	3.1E+01	8.5E-02	2.5E-02	1.1E+01	2.4E-03
4,4'-DDD	5.4E-04	2.6E-01	2.1E-03	2.9E-06	8.3E-02	3.5E-05
4,4'-DDE	6.5E-04	2.6E-01	2.5E-03	6.8E-06	8.3E-02	8.2E-05
4,4'-DDT	2.1E-03	2.6E-01	8.1E-03	1.4E-05	8.3E-02	1.6E-04
Aldrin	1.7E-05	3.5E-01	4.9E-05	5.9E-07	6.9E-02	8.6E-06
Alpha-BHC	4.2E-04	3.0E+00	1.4E-04	2.3E-06	1.0E+00	2.2E-06
Alpha-Chlordane	6.0E-05	1.5E-01	4.1E-04	1.1E-06	5.2E-01	2.0E-06
Dieldrin	3.3E-04	3.5E-01	9.7E-04	3.8E-06	6.9E-02	5.5E-05
Endosulfan I	4.8E-05	1.4E-01	3.4E-04	2.3E-07	4.8E-02	4.8E-06
Endosulfan II	3.3E-04	1.4E-01	2.4E-03	2.4E-06	4.8E-02	5.1E-05
Gamma-BHC (Lindane)	2.2E-03	6.0E+00	3.7E-04	9.1E-06	1.7E+01	5.3E-07
Gamma-Chlordane	3.3E-05	1.5E-01	2.2E-04	1.6E-07	5.2E-01	3.0E-07
Heptachlor Epoxide	3.1E-06	4.2E-01	7.2E-06	2.4E-06	1.8E-02	1.4E-04
PCB-1016	1.6E-03	8.7E+00	1.8E-04	7.4E-06	5.2E-02	1.4E-04
Aluminum	1.9E+02	2.3E+02	8.3E-01	8.9E-01	7.8E+01	1.1E-02
Antimony	1.3E-01	5.1E+01	2.7E-03	9.5E-04	1.7E+01	5.5E-05
Arsenic	3.4E-01	9.1E+00	3.7E-02	1.6E-03	2.1E+01	7.9E-05
Barium	6.3E-01	1.1E+02	5.7E-03	6.5E-03	1.3E+02	5.2E-05
Beryllium	3.7E-03	1.0E+00	3.6E-03	2.2E-05	3.5E-01	6.3E-05
Cadmium	5.7E-01	6.8E+00	8.4E-02	2.2E-03	1.0E+00	2.2E-03

TABLE A4-4
RISK ESTIMATION OF SUBLETHAL EFFECTS TO TERRESTRIAL ORGANISMS FROM FOOD CONSUMPTION AND SURFACE SOIL I

TERRESTRIAL HABITAT
STAGE II ECOLOGICAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON MASSACHUSETTS

CHEMICAL	American Woodcock			Red Fox		
	TBD	RTV	HQ	TBD	RTV	HQ
Chromium	1.3E+01	3.7E+02	3.6E-02	7.4E-02	5.8E+02	1.3E-04
Cobalt	3.8E-01	1.6E+01	2.4E-02	1.6E-03	5.4E+00	2.9E-04
Copper	4.2E-01	5.3E+01	7.8E-03	8.1E-03	1.8E+01	4.4E-04
Cyanide	1.7E-02	7.8E+00	2.2E-03	8.1E-05	3.4E+01	2.4E-06
Lead	1.1E+00	8.7E+00	1.3E-01	5.4E-03	2.9E+00	1.8E-03
Manganese	1.9E+00	1.2E+02	1.5E-02	3.6E-02	4.1E+01	8.7E-04
Mercury	6.6E-02	4.1E-01	1.6E-01	2.8E-04	1.4E-01	2.0E-03
Nickel	2.2E-01	8.9E+00	2.5E-02	1.5E-03	8.6E+01	1.8E-05
Selenium	4.5E-01	1.3E+00	3.4E-01	2.8E-03	8.3E-02	3.3E-02
Thallium	1.4E-02	2.3E+00	5.9E-03	2.6E-04	7.9E-01	3.3E-04
Vanadium	4.5E-01	2.0E+01	2.3E-02	2.4E-03	6.2E+00	3.9E-04
Zinc	1.5E+01	2.4E+02	6.1E-02	1.1E-01	8.3E+01	1.3E-03
Chloride	2.1E+00	NA	NA	1.0E-02	NA	NA
Nitrogen, Ammonia	2.8E+00	NA	NA	1.3E-02	NA	NA
Sulfate as SO4	4.5E+01	NA	NA	2.2E-01	NA	NA
SUMMARY HAZARD INDEX			1.9E+00			5.8E-02

TBD = Total Body Dose (mg/kgBW-day).
RTV = Reference Toxicity Value (mg/kgBW-day), wildlife RTVs are presented in Table A4-3.
HQ = Hazard Quotient (calculated by dividing TBD by RTV)
TBD = Total Body Dose (mg/kgBW-day)
NA = Not Available

TABLE A4-4
ESTIMATION OF CHRONIC EXPOSURES TO TERRESTRIAL ORGANISMS VIA FOOD CONSUMPTION AND SURFACE SOIL INGESTION

TERRESTRIAL HABITAT
STAGE II ECOLOGICAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON MASSACHUSETTS

TOTAL BODY DOSE (mg/kgBW-day) [b]

Chemical	American Woodcock	Red Fox
1,1,1-Trichloroethane	2.6E-04	1.2E-06
1,1-Dichloroethene	2.1E-05	9.8E-08
2,4,4-Trimethyl-1-pentene	2.4E-05	1.1E-07
Acetone	3.3E-04	1.6E-06
Methylene Chloride	1.4E-04	6.5E-07
Tetrachloroethene (PCE)	5.0E-05	2.4E-07
Toluene	6.8E-05	3.2E-07
2-Methylnaphthalene	1.5E-01	7.1E-04
Acenaphthene	4.7E-02	2.2E-04
Acenaphthylene	1.1E-01	5.4E-04
Anthracene	7.8E-02	3.7E-04
Benzo(a)Anthracene	4.0E-02	1.9E-04
Benzo(a)Pyrene	2.9E-02	1.4E-04
Benzo(b)Fluoranthene	1.5E-02	7.0E-05
Benzo(g,h,i)Perylene	9.7E-03	4.6E-05
Benzo(k)Fluoranthene	2.0E-02	9.4E-05
Benzoic Acid	1.4E-01	5.3E-04
Butylbenzylphthalate	5.8E-03	2.7E-05
Chrysene	4.3E-02	2.0E-04
Di-n-butylphthalate	1.9E-02	8.5E-05
Di-n-octylphthalate	3.2E-03	1.5E-05
Dibenzofuran	1.2E-02	5.9E-05
Diethylphthalate	7.5E-04	3.6E-06
Fluoranthene	1.1E-01	5.3E-04
Fluorene	1.2E-01	5.5E-04
Indeno (1,2,3-cd)Pyrene	8.7E-03	4.1E-05
N-Nitrosodiphenylamine (1)	3.7E-02	1.6E-04
Naphthalene	1.5E-01	7.1E-04
Phenanthrene	2.8E-01	1.3E-03
Phenol	1.3E-02	4.5E-04
Pyrene	9.1E-02	4.3E-04
bis(2-EthylHexyl)phthalate	2.7E+00	2.5E-02
4,4'-DDD	5.4E-04	2.9E-06
4,4'-DDE	6.5E-04	6.8E-06
4,4'-DDT	2.1E-03	1.4E-05
Aldrin	1.7E-05	5.9E-07
Alpha-BHC	4.2E-04	2.3E-06
Alpha-Chlordane	6.0E-05	1.1E-06
Dieldrin	3.3E-04	3.8E-06
Endosulfan I	4.8E-05	2.3E-07
Endosulfan II	3.3E-04	2.4E-06
Gamma-BHC (Lindane)	2.2E-03	9.1E-06
Gamma-Chlordane	3.3E-05	1.6E-07
Heptachlor Epoxide	3.1E-06	2.4E-06
PCB-1016	1.6E-03	7.4E-06
Aluminum	1.9E+02	8.9E-01
Antimony	1.3E-01	9.5E-04
Arsenic	3.4E-01	1.6E-03
Barium	6.3E-01	6.5E-03
Beryllium	3.7E-03	2.2E-05
Cadmium	5.7E-01	2.2E-03
Chromium	1.3E+01	7.4E-02

TABLE A4-4
ESTIMATION OF CHRONIC EXPOSURES TO TERRESTRIAL ORGANISMS VIA FOOD CONSUMPTION AND SURFACE SOIL INGESTION

TERRESTRIAL HABITAT
STAGE II ECOLOGICAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON MASSACHUSETTS

TOTAL BODY DOSE (mg/kgBW-day) [b]

Chemical	American Woodcock	Red Fox
Cobalt	3.8E-01	1.6E-03
Copper	4.2E-01	8.1E-03
Cyanide	1.7E-02	8.1E-05
Lead	1.1E+00	5.4E-03
Manganese	1.9E+00	3.6E-02
Mercury	6.6E-02	2.8E-04
Nickel	2.2E-01	1.5E-03
Selenium	4.5E-01	2.8E-03
Thallium	1.4E-02	2.6E-04
Vanadium	4.5E-01	2.4E-03
Zinc	1.5E+01	1.1E-01
Chloride	2.1E+00	1.0E-02
Nitrogen, Ammonia	2.8E+00	1.3E-02
Sulfate as SO4	4.5E+01	2.2E-01

[b] Calculated by summing the products of individual prey type concentrations and percent in diet, multiplying by the SFF and ingestion rate, and then dividing by body weight.

TABLE A4-4

ESTIMATION OF CHRONIC EXPOSURES TO TERRESTRIAL ORGANISMS VIA FOOD CONSUMPTION AND SURFACE SOIL INGESTION

TERRESTRIAL HABITAT
STAGE II ECOLOGICAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON MASSACHUSETTS

EXPOSURE PARAMETERS [c]

Indicator Species		Percent Prey in Diet: Inverts	Plants	Small Mammals	Amphibians	Birds	Soil	Home Range (acres)	Site Foraging Frequency [d]	Dietary Ingestion Rate (kg/day)	Water Ingestion Rate (l/day)	Body Weight (kg)	Exposure Duration
American Woodcock	(Small Bird)	85%	5%	0%	0%	0%	10%	50	2.2E-01	0.22	0.021	0.2	0.75
Red fox	(Pred. Mammal)	20%	10%	42%	15%	10%	3%	250	4.3E-02	0.32	0.41	4.9	1

SITE AREA:	10.82	acres

NOTES:

[c] Documentation of exposure parameters presented in: Attachment 4, Table A4-1.

[d] Site Foraging Frequency (SFF). Calculated by dividing site area by receptor home range (cannot exceed 1.0)

TABLE A4-5
ESTIMATION OF CHRONIC EXPOSURES TO SEMI-AQUATIC RECEPTORS VIA FOOD, WATER, AND SEDIMENT INGESTION

OFF-PROPERTY WEST DITCH - AQUATIC HABITAT
STAGE II ECOLOGICAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON MASSACHUSETTS

	EXPOSURE CONCENTRATION DATA		TISSUE LEVELS IN PRIMARY PREY ITEMS (Site Specific)	
CHEMICAL	AVERAGE SEDIMENT CONCENTRATION (mg/kg)	AVERAGE SURFACE WATER CONCENTRATION (mg/L)	Invertebrate Tissue Level [a] (mg/kg)	Amphibian Tissue Level [a] (mg/kg)
1,1,1-Trichloroethane	6.7E-03	ND	NA	NA
1,1-Dichloroethane	4.0E-03	ND	NA	NA
2,4,4-Trimethyl-1-pentene	7.6E-01	4.9E-02	NA	NA
2,4,4-Trimethyl-2-Pentene	2.1E-01	2.1E-02	NA	NA
Acetone	2.9E-02	1.6E-02	NA	NA
Bromoform	2.2E-02	2.3E-03	NA	NA
Carbon Tetrachloride	4.8E-03	ND	NA	NA
Chloroform	4.6E-03	ND	NA	NA
Dibromochloromethane	8.2E-03	ND	NA	NA
Methylene Chloride	8.8E-03	ND	NA	NA
Toluene	5.8E-03	ND	NA	NA
Trichloroethene (TCE)	3.0E-03	ND	NA	NA
Xylenes, Total	4.7E-03	ND	NA	NA
1,2,4-Trichlorobenzene	2.1E-01	ND	ND	ND
4-Bromophenyl-phenylether	3.5E-01	ND	ND	ND
4-Chlorophenyl-phenylether	1.0E-01	ND	ND	ND
Benzo(a)Anthracene	2.8E-01	ND	ND	ND
Benzo(b)Fluoranthene	4.5E-01	ND	ND	ND
Benzo(g,h,i)Perylene	2.8E-01	ND	ND	ND
Benzo(k)Fluoranthene	2.8E-01	ND	ND	ND
Benzoic Acid	1.7E-01	ND	ND	ND
Chrysene	3.6E-01	ND	ND	ND
Di-n-butylphthalate	8.6E-02	ND	ND	ND
Di-n-octylphthalate	ND	1.0E-03	ND	ND
Fluoranthene	6.3E-01	ND	ND	ND
Indeno (1,2,3-cd)Pyrene	2.9E-01	ND	ND	ND
N-Nitrosodiphenylamine (1)	3.6E-01	9.5E-03	ND	ND
Phenanthrene	2.8E-01	ND	ND	ND
Phenol	ND	3.0E-03	7.9E-02	ND
Pyrene	4.3E-01	ND	ND	ND
bis(2-EthylHexyl)phthalate	1.5E+00	6.0E-03	2.5E+00	1.2E+01
4,4'-DDD	2.4E-02	ND	ND	2.0E-03
Alpha-BHC	5.2E-03	ND	ND	9.0E-04
Beta-BHC	2.4E-02	ND	ND	1.0E-03
Delta-BHC	2.0E-02	ND	ND	ND
Endosulfan I	1.8E-02	ND	ND	ND
Endosulfan Sulfate	3.2E-02	ND	ND	9.3E-03
Endrin Aldehyde	1.2E-02	ND	ND	2.0E-03
Heptachlor Epoxide	2.1E-02	1.0E-04	ND	1.2E-03
Aluminum	2.2E+04	1.1E+01	9.6E+01	9.8E+01
Antimony	6.4E+01	ND	ND	1.8E-01
Barium	1.3E+01	2.7E-02	1.9E+01	2.1E+00
Beryllium	9.2E-01	ND	ND	1.1E-02
Cadmium	6.8E-01	ND	5.3E-02	1.6E-01
Chromium	2.2E+03	2.7E+00	1.5E+01	3.2E+01
Cobalt	3.4E+00	3.7E-02	3.1E-01	1.0E-01
Copper	2.7E+01	3.4E-02	3.4E+01	2.7E+00
Lead	1.7E+01	5.0E-03	3.7E-01	2.4E-01

TABLE A4-5
ESTIMATION OF CHRONIC EXPOSURES TO SEMI-AQUATIC RECEPTORS VIA FOOD, WATER, AND SEDIMENT INGESTION

OFF-PROPERTY WEST DITCH - AQUATIC HABITAT
STAGE II ECOLOGICAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON MASSACHUSETTS

EXPOSURE CONCENTRATION DATA

CHEMICAL	AVERAGE SEDIMENT CONCENTRATION (mg/kg)	AVERAGE SURFACE WATER CONCENTRATION (mg/L)
Manganese	ND	1.7E+00
Mercury	1.5E-01	ND
Nickel	7.0E+00	4.4E-02
Vanadium	1.3E+01	ND
Zinc	1.8E+01	8.3E-02
Chloride	3.2E+02	ND
Nitrate as N	2.9E+00	ND
Nitrogen, Ammonia	1.9E+02	ND
Sulfate as SO4	1.1E+03	ND

TISSUE LEVELS IN PRIMARY PREY ITEMS (Site Specific)

Invertebrate Tissue Level [a] (mg/kg)	Amphibian Tissue Level [a] (mg/kg)
3.6E+01	1.2E+01
2.6E-02	3.6E-02
1.6E-01	1.2E-01
3.8E-01	2.2E-01
2.8E+01	2.1E+01
NA	NA
NA	NA
NA	NA
NA	NA

[a] Invertebrate and amphibian tissue concentrations are presented in Attachment 1, Tables A1-3 and A1-4, respectively.

NA = Not Analysed

ND = Not Detected

TABLE A4-5
RISK ESTIMATION OF SUBLETHAL EFFECTS TO SEMI-AQUATIC RECEPTORS VIA FOOD, WATER, AND SEDIMENT INGESTION

OFF-PROPERTY WEST DITCH - AQUATIC HABITAT
STAGE II ECOLOGICAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON MASSACHUSETTS

CHEMICAL	Green heron		
	TBD	RTV	HQ
1,1,1-Trichloroethane	3.8E-06	1.5E+02	2.6E-08
1,1-Dichloroethane	2.3E-06	1.1E+01	2.1E-07
2,4,4-Trimethyl-1-pentene	9.9E-04	NA	
2,4,4-Trimethyl-2-Pentene	3.6E-04	NA	
Acetone	2.0E-04	5.9E+02	3.3E-07
Bromoform	3.9E-05	2.7E+01	1.4E-06
Carbon Tetrachloride	2.7E-06	8.4E+00	3.2E-07
Chloroform	2.6E-06	5.2E+01	5.0E-08
Dibromochloromethane	4.7E-06	NA	
Methylene Chloride	5.0E-06	6.2E+01	8.0E-08
Toluene	3.3E-06	5.3E+02	6.2E-09
Trichloroethene (TCE)	1.7E-06	2.5E+01	6.8E-08
Xylenes, Total	2.7E-06	5.9E+02	4.5E-09
1,2,4-Trichlorobenzene	1.2E-04	NA	
4-Bromophenyl-phenylether	2.0E-04	NA	
4-Chlorophenyl-phenylether	5.7E-05	NA	
Benzo(a)Anthracene	1.6E-04	2.1E+00	7.6E-05
Benzo(b)Fluoranthene	2.6E-04	4.2E+01	6.0E-06
Benzo(g,h,i)Perylene	1.6E-04	1.0E+02	1.5E-06
Benzo(k)Fluoranthene	1.6E-04	4.2E+01	3.8E-06
Benzoic Acid	9.7E-05	NA	
Chrysene	2.1E-04	1.0E+02	2.0E-06
Di-n-butylphthalate	4.9E-05	1.5E+02	3.3E-07
Di-n-octylphthalate	1.1E-05	2.1E+02	5.5E-08
Fluoranthene	3.6E-04	1.3E+02	2.8E-06
Indeno (1,2,3-cd)Pyrene	1.7E-04	7.6E+01	2.2E-06
N-Nitrosodiphenylamine (1)	3.1E-04	3.9E+01	8.0E-06
Phenanthrene	1.6E-04	1.4E+02	1.1E-06
Phenol	4.8E-04	1.4E+02	3.4E-06
Pyrene	2.4E-04	6.5E+01	3.7E-06
bis(2-EthylHexyl)phthalate	7.7E-02	3.1E+01	2.5E-03
4,4'-DDD	2.4E-05	1.8E-01	1.3E-04
Alpha-BHC	7.6E-06	3.0E+00	2.6E-06
Beta-BHC	1.9E-05	NA	
Delta-BHC	1.1E-05	NA	
Endosulfan I	1.0E-05	1.4E-01	7.7E-05
Endosulfan Sulfate	6.6E-05	1.4E-01	4.8E-04
Endrin Aldehyde	1.7E-05	2.8E-01	6.2E-05
Heptachlor Epoxide	1.9E-05	4.1E-01	4.6E-05
Aluminum	1.4E+01	2.2E+02	6.1E-02
Antimony	3.8E-02	5.0E+01	7.6E-04
Barium	1.3E-01	1.1E+02	1.2E-03
Beryllium	5.8E-04	1.0E+00	5.8E-04
Cadmium	1.5E-03	6.6E+00	2.3E-04
Chromium	1.5E+00	3.6E+02	4.2E-03
Cobalt	4.7E-03	1.5E+01	3.0E-04
Copper	2.2E-01	5.2E+01	4.3E-03
Lead	1.3E-02	8.6E+00	1.5E-03

TABLE A4-5
RISK ESTIMATION OF SUBLETHAL EFFECTS TO SEMI-AQUATIC RECEPTORS VIA FOOD, WATER, AND SEDIMENT INGESTION

OFF-PROPERTY WEST DITCH - AQUATIC HABITAT
STAGE II ECOLOGICAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON MASSACHUSETTS

CHEMICAL	*Green heron*		
	TBD	RTV	HQ
1,1,1-Trichloroethane	3.8E-06	1.5E+02	2.6E-08
Manganese	2.9E-01	1.2E+02	2.4E-03
Mercury	4.2E-04	4.0E-01	1.0E-03
Nickel	6.0E-03	8.7E+00	6.9E-04
Vanadium	1.1E-02	1.9E+01	5.4E-04
Zinc	2.8E-01	2.4E+02	1.2E-03
Chloride	1.8E-01	NA	
Nitrate as N	1.6E-03	NA	
Nitrogen, Ammonia	1.1E-01	NA	
Sulfate as SO4	6.4E-01	NA	
SUMMARY HAZARD INDEX			8.4E-02

TBD = Total Body Dose (mg/kgBW-day).
RTV = Reference Toxicity Value (mg/kgBW-day); wildlife RTVs are presented in Table A4-3.
HQ = Hazard Quotient (calculated by dividing TBD by RTV)
NA = Not Available

TABLE A4-5
RISK ESTIMATION OF SUBLETHAL EFFECTS TO SEMI-AQUATIC RECEPTORS VIA FOOD, WATER, AND SEDIMENT INGESTION

OFF-PROPERTY WEST DITCH - AQUATIC HABITAT
STAGE II ECOLOGICAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON MASSACHUSETTS

TOTAL BODY DOSE (mg/kgBW-day) [b]

CHEMICAL	*Green heron*
1,1,1-Trichloroethane	3.8E-06
1,1-Dichloroethane	2.3E-06
2,4,4-Trimethyl-1-pentene	9.9E-04
2,4,4-Trimethyl-2-Pentene	3.6E-04
Acetone	2.0E-04
Bromoform	3.9E-05
Carbon Tetrachloride	2.7E-06
Chloroform	2.6E-06
Dibromochloromethane	4.7E-06
Methylene Chloride	5.0E-06
Toluene	3.3E-06
Trichloroethene (TCE)	1.7E-06
Xylenes, Total	2.7E-06
1,2,4-Trichlorobenzene	1.2E-04
4-Bromophenyl-phenylether	2.0E-04
4-Chlorophenyl-phenylether	5.7E-05
Benzo(a)Anthracene	1.6E-04
Benzo(b)Fluoranthene	2.6E-04
Benzo(g,h,i)Perylene	1.6E-04
Benzo(k)Fluoranthene	1.6E-04
Benzoic Acid	9.7E-05
Chrysene	2.1E-04
Di-n-butylphthalate	4.9E-05
Di-n-octylphthalate	1.1E-05
Fluoranthene	3.6E-04
Indeno (1,2,3-cd)Pyrene	1.7E-04
N-Nitrosodiphenylamine (1)	3.1E-04
Phenanthrene	1.6E-04
Phenol	4.8E-04
Pyrene	2.4E-04
bis(2-EthylHexyl)phthalate	7.7E-02
4,4'-DDD	2.4E-05
Alpha-BHC	7.6E-06
Beta-BHC	1.9E-05
Delta-BHC	1.1E-05
Endosulfan I	1.0E-05
Endosulfan Sulfate	6.6E-05
Endrin Aldehyde	1.7E-05
Heptachlor Epoxide	1.9E-05
Aluminum	1.4E+01
Antimony	3.8E-02
Barium	1.3E-01
Beryllium	5.8E-04
Cadmium	1.5E-03
Chromium	1.5E+00
Cobalt	4.7E-03
Copper	2.2E-01
Lead	1.3E-02

TABLE A4-5
RISK ESTIMATION OF SUBLETHAL EFFECTS TO SEMI-AQUATIC RECEPTORS VIA FOOD, WATER, AND SEDIMENT INGESTION

OFF-PROPERTY WEST DITCH - AQUATIC HABITAT
STAGE II ECOLOGICAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON MASSACHUSETTS

TOTAL BODY DOSE (mg/kgBW-day) [b]

CHEMICAL	*Green heron*
Manganese	2.9E-01
Mercury	4.2E-04
Nickel	6.0E-03
Vanadium	1.1E-02
Zinc	2.8E-01
Chloride	1.8E-01
Nitrate as N	1.6E-03
Nitrogen, Ammonia	1.1E-01
Sulfate as SO4	6.4E-01

[b] Calculated by summing the products of individual prey type concentrations and percent in diet surface water and sediment exposures, multiplying by the exposure duration, SFF and ingestion rat and dividing by body weight.

TABLE A4-5
ESTIMATION OF CHRONIC EXPOSURES TO SEMI-AQUATIC RECEPTORS VIA FOOD, WATER, AND SEDIMENT INGESTION

OFF-PROPERTY WEST DITCH - AQUATIC HABITAT
STAGE II ECOLOGICAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON MASSACHUSETTS

EXPOSURE PARAMETERS [c]

Indicator Species		Percent Prey in Diet: Amphibians	Inverts	Plants	Sediment	Home Rang (acres)	ED [d]	Site Foraging Frequency [e]	Dietary Ingestion Rate (kg/day)	Water Ingestion Rate (L/day)	Body Weight (kg)
Green heron	(Carn. bird)	50%	45%	0%	5%	1	0.5	2.30E-01	0.021	0.021	0.21

SITE AREA:	0.23	acres

NOTES:

[c] Documentation of exposure parameters presented in Attachment 4, Table A4-1.

[d] ED = Exposure Duration (percentage of year receptor is expected to be found at study area)

[e] SFF = Site Foraging Frequency (calculated by dividing site area by receptor home range (cannot exceed 1.0))

TABLE A4-6
ESTIMATION OF CHRONIC EXPOSURES TO SEMI-AQUATIC RECEPTORS VIA FOOD, WATER, AND SEDIMENT INGESTION

ON-PROPERTY WEST DITCH - AQUATIC HABITAT
STAGE II ECOLOGICAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON MASSACHUSETTS

EXPOSURE CONCENTRATION DATA | TISSUE LEVELS IN PRIMARY PREY ITEMS (Site Specific)

CHEMICAL	AVERAGE SEDIMENT CONCENTRATION (mg/kg)	AVERAGE SURFACE WATER CONCENTRATION (mg/L)	Invertebrate Tissue Level [a] (mg/kg)	Amphibian Tissue Level [a] (mg/kg)
2,4,4-Trimethyl-1-pentene	1.0E+01	ND	NA	NA
2,4,4-Trimethyl-2-Pentene	3.7E+00	ND	NA	NA
Acetone	1.5E-01	ND	NA	NA
Benzene	1.5E-02	ND	NA	NA
Chlorobenzene	7.0E-03	ND	NA	NA
Ethylbenzene	2.1E-01	ND	NA	NA
Toluene	4.0E-01	ND	NA	NA
1,2,4-Trichlorobenzene	1.4E+00	ND	ND	ND
1,2-Dichlorobenzene	1.6E+00	ND	ND	ND
2-Methylnaphthalene	1.4E+00	ND	ND	ND
Benzo(a)Anthracene	2.1E+00	ND	ND	ND
Benzo(b)Fluoranthene	8.7E-01	ND	ND	ND
Benzoic Acid	2.0E+00	ND	ND	ND
Butylbenzylphthalate	1.6E+02	ND	ND	ND
Di-n-butylphthalate	7.3E+02	ND	ND	ND
Di-n-octylphthalate	2.1E+00	ND	ND	ND
Dibenzofuran	5.9E+00	ND	ND	ND
Dimethylphthalate	1.8E-01	ND	ND	ND
Fluoranthene	4.1E+00	ND	ND	ND
Fluorene	4.0E+00	ND	ND	ND
N-Nitrosodiphenylamine (1)	1.9E+03	ND	ND	ND
Naphthalene	2.2E+00	ND	ND	ND
Phenanthrene	3.4E+01	ND	ND	ND
Phenol	5.6E+01	ND	7.9E-02	ND
Pyrene	9.1E+00	ND	ND	ND
bis(2-EthylHexyl)phthalate	3.8E+04	ND	2.5E+00	1.2E+01
4,4'-DDT	2.7E-01	ND	ND	3.7E-03
Aldrin	1.1E-01	ND	ND	1.2E-03
Beta-BHC	1.1E-01	ND	ND	1.0E-03
Endosulfan I	9.9E-02	ND	ND	ND
Endrin Aldehyde	5.5E-01	ND	ND	2.0E-03
Heptachlor	1.2E-01	ND	ND	ND
Aluminum	4.9E+03	1.9E-01	9.6E+01	9.7E+01
Antimony	1.9E+00	ND	ND	1.8E-01
Barium	2.5E+01	8.0E-03	1.9E+01	2.1E+00
Beryllium	2.8E-01	ND	ND	1.0E-02
Cadmium	6.2E-01	ND	5.3E-02	1.6E-01
Chromium	2.7E+02	ND	1.5E+01	3.2E+01
Cobalt	1.9E+00	ND	3.1E-01	1.0E-01
Copper	1.3E+01	ND	3.4E+01	2.7E+00
Lead	1.7E+01	ND	3.7E-01	2.4E-01
Mercury	2.5E-01	ND	2.6E-02	3.6E-02
Nickel	7.1E+00	ND	1.6E-01	1.2E-01
Vanadium	1.8E+01	ND	3.8E-01	2.2E-01
Zinc	7.4E+01	1.9E-02	2.8E+01	2.1E+01
Chloride	1.1E+02	2.2E+02	NA	NA
Nitrate as N	3.7E+00	6.4E+00	NA	NA
Nitrite as N	2.2E+00	5.4E-02	NA	NA

TABLE A4-6
ESTIMATION OF CHRONIC EXPOSURES TO SEMI-AQUATIC RECEPTORS VIA FOOD, WATER, AND SEDIMENT INGESTION

ON-PROPERTY WEST DITCH - AQUATIC HABITAT
STAGE II ECOLOGICAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON MASSACHUSETTS

EXPOSURE CONCENTRATION DATA

CHEMICAL	AVERAGE SEDIMENT CONCENTRATION (mg/kg)	AVERAGE SURFACE WATER CONCENTRATION (mg/L)
Nitrogen, Ammonia	1.1E+02	1.6E-01
Sulfate as SO4	3.2E+02	7.7E+01

TISSUE LEVELS IN PRIMARY PREY ITEMS (Site Specific)

Invertebrate Tissue Level [a] (mg/kg)	Amphibian Tissue Level [a] (mg/kg)
NA	NA
NA	NA

[a] Invertebrate and amphibian tissue concentrations are presented in Table Attachment 1, Tables A1-3 and A1-4, respectively.

NA = Not Analysed

ND = Not Detected

TABLE A4-6
RISK ESTIMATION OF SUBLETHAL EFFECTS TO SEMI-AQUATIC RECEPTORS VIA FOOD, WATER, AND SEDIMENT INGESTION

ON-PROPERTY WEST DITCH - AQUATIC HABITAT
STAGE II ECOLOGICAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON MASSACHUSETTS

CHEMICAL	Green heron		
	TBD	RTV	HQ
2,4,4-Trimethyl-1-pentene	4.3E-03	NA	
2,4,4-Trimethyl-2-Pentene	1.5E-03	NA	
Acetone	6.3E-05	5.9E+02	1.1E-07
Benzene	6.3E-06	1.2E+01	5.3E-07
Chlorobenzene	2.9E-06	4.7E+01	6.3E-08
Ethylbenzene	8.7E-05	3.5E+02	2.5E-07
Toluene	1.7E-04	5.3E+02	3.2E-07
1,2,4-Trichlorobenzene	5.9E-04	2.4E+01	2.5E-05
1,2-Dichlorobenzene	6.7E-04	NA	
2-Methylnaphthalene	5.9E-04	3.9E+01	1.5E-05
Benzo(a)Anthracene	8.8E-04	2.1E+00	4.2E-04
Benzo(b)Fluoranthene	3.7E-04	4.2E+01	8.6E-06
Benzoic Acid	8.4E-04	NA	
Butylbenzylphthalate	6.7E-02	1.9E+02	3.6E-04
Di-n-butylphthalate	3.1E-01	1.5E+02	2.1E-03
Di-n-octylphthalate	8.8E-04	2.1E+02	4.3E-06
Dibenzofuran	2.5E-03	1.3E+02	1.9E-05
Dimethylphthalate	7.6E-05	3.7E+03	2.0E-08
Fluoranthene	1.7E-03	1.3E+02	1.3E-05
Fluorene	1.7E-03	1.3E+02	1.3E-05
N-Nitrosodiphenylamine (1)	8.0E-01	3.9E+01	2.0E-02
Naphthalene	9.3E-04	4.3E+01	2.2E-05
Phenanthrene	1.4E-02	1.4E+02	1.0E-04
Phenol	2.4E-02	1.4E+02	1.7E-04
Pyrene	3.8E-03	6.5E+01	5.9E-05
bis(2-EthylHexyl)phthalate	1.6E+01	3.1E+01	5.2E-01
4,4'-DDT	1.3E-04	1.8E-01	7.0E-04
Aldrin	5.0E-05	3.4E-01	1.5E-04
Beta-BHC	4.9E-05	3.0E+00	1.7E-05
Endosulfan I	4.2E-05	1.4E-01	3.1E-04
Endrin Aldehyde	2.4E-04	2.8E-01	8.7E-04
Heptachlor	4.9E-05	4.1E-01	1.2E-04
Aluminum	2.8E+00	2.2E+02	1.3E-02
Antimony	1.5E-03	5.0E+01	3.0E-05
Barium	9.9E-02	1.1E+02	9.1E-04
Beryllium	1.6E-04	1.0E+00	1.5E-04
Cadmium	1.1E-03	6.6E+00	1.6E-04
Chromium	3.0E-01	3.6E+02	8.2E-04
Cobalt	2.5E-03	1.5E+01	1.6E-04
Copper	1.6E-01	5.2E+01	3.0E-03
Lead	9.7E-03	8.6E+00	1.1E-03
Mercury	3.5E-04	4.0E-01	8.8E-04
Nickel	4.1E-03	8.7E+00	4.7E-04
Vanadium	1.0E-02	1.9E+01	5.1E-04
Zinc	2.3E-01	2.4E+02	9.6E-04
Chloride	1.9E+00	NA	
Nitrate as N	5.5E-02	NA	
Nitrite as N	1.4E-03	NA	

TABLE A4-6
RISK ESTIMATION OF SUBLETHAL EFFECTS TO SEMI-AQUATIC RECEPTORS VIA FOOD, WATER, AND SEDIMENT INGESTION

ON-PROPERTY WEST DITCH - AQUATIC HABITAT
STAGE II ECOLOGICAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON MASSACHUSETTS

CHEMICAL	Green heron		
	TBD	RTV	HQ
Nitrogen, Ammonia	4.6E-02	NA	
Sulfate as SO4	7.8E-01	NA	
SUMMARY HAZARD INDEX			5.7E-01

TBD = Total Body Dose (mg/kgBW-day).
RTV = Reference Toxicity Value (mg/kgBW-day); wildlife RTVs presented in Table A4-3.
HQ = Hazard Quotient (calculated by dividing TBD by RTV)
NA = Not Available

TABLE A4-6
RISK ESTIMATION OF SUBLETHAL EFFECTS TO SEMI-AQUATIC
RECEPTORS VIA FOOD, WATER, AND SEDIMENT INGESTION

ON-PROPERTY WEST DITCH - AQUATIC HABITAT
STAGE II ECOLOGICAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON MASSACHUSETTS

TOTAL BODY DOSE (mg/kgBW-day) [c]

CHEMICAL	*Green heron*
2,4,4-Trimethyl-1-pentene	4.3E-03
2,4,4-Trimethyl-2-Pentene	1.5E-03
Acetone	6.3E-05
Benzene	6.3E-06
Chlorobenzene	2.9E-06
Ethylbenzene	8.7E-05
Toluene	1.7E-04
1,2,4-Trichlorobenzene	5.9E-04
1,2-Dichlorobenzene	6.7E-04
2-Methylnaphthalene	5.9E-04
Benzo(a)Anthracene	8.8E-04
Benzo(b)Fluoranthene	3.7E-04
Benzoic Acid	8.4E-04
Butylbenzylphthalate	6.7E-02
Di-n-butylphthalate	3.1E-01
Di-n-octylphthalate	8.8E-04
Dibenzofuran	2.5E-03
Dimethylphthalate	7.6E-05
Fluoranthene	1.7E-03
Fluorene	1.7E-03
N-Nitrosodiphenylamine (1)	8.0E-01
Naphthalene	9.3E-04
Phenanthrene	1.4E-02
Phenol	2.4E-02
Pyrene	3.8E-03
bis(2-EthylHexyl)phthalate	1.6E+01
4,4'-DDT	1.3E-04
Aldrin	5.0E-05
Beta-BHC	4.9E-05
Endosulfan I	4.2E-05
Endrin Aldehyde	2.4E-04
Heptachlor	4.9E-05
Aluminum	2.8E+00
Antimony	1.5E-03
Barium	9.9E-02
Beryllium	1.6E-04
Cadmium	1.1E-03
Chromium	3.0E-01
Cobalt	2.5E-03
Copper	1.6E-01
Lead	9.7E-03
Mercury	3.5E-04
Nickel	4.1E-03
Vanadium	1.0E-02
Zinc	2.3E-01
Chloride	1.9E+00
Nitrate as N	5.5E-02
Nitrite as N	1.4E-03

TABLE A4-6
RISK ESTIMATION OF SUBLETHAL EFFECTS TO SEMI-AQUATIC
RECEPTORS VIA FOOD, WATER, AND SEDIMENT INGESTION

ON-PROPERTY WEST DITCH - AQUATIC HABITAT
STAGE II ECOLOGICAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON MASSACHUSETTS

TOTAL BODY DOSE (mg/kgBW-day) [c]

CHEMICAL	*Green heron*
Nitrogen, Ammonia	4.6E-02
Sulfate as SO4	7.8E-01

[b] Calculated by summing the products of individual prey type concentrations and percent in diet surface water and sediment exposures, multiplying by the exposure duration, SFF and ingestion rat and dividing by body weight.

TABLE A4-6
ESTIMATION OF CHRONIC EXPOSURES TO SEMI-AQUATIC RECEPTORS VIA FOOD, WATER, AND SEDIMENT INGESTION

ON-PROPERTY WEST DITCH - AQUATIC HABITAT
STAGE II ECOLOGICAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON MASSACHUSETTS

EXPOSURE PARAMETERS [c]

Indicator Species		Percent Prey in Diet: Amphibian	Insects	Plants	Sediment	Home Rang (acres)	ED [d]	Site Foraging Frequency [e]	Dietary Ingestion Rate (kg/day)	Water Ingestion Rate (L/day)	Body Weight (kg)
Green heron	(Carn. bird)	50%	45%	0%	5%	1	0.5	1.70E-01	0.021	0.021	0.21

SITE AREA:	0.17	acres

NOTES:

[c] Documentation of exposure parameters presented in Attachment 4, Table A4-1.

[d] ED = Exposure Duration (percentage of year receptor is expected to be found at study area)

[e] SFF = Site Foraging Frequency (calculated by dividing site area by receptor home range (cannot exceed 1.0))

TABLE A4-7
ESTIMATION OF CHRONIC EXPOSURES TO SEMI-AQUATIC RECEPTORS VIA FOOD, WATER, AND SEDIMENT INGESTION

SOUTH DITCH - AQUATIC HABITAT
STAGE II ECOLOGICAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON MASSACHUSETTS

EXPOSURE CONCENTRATION DATA / **TISSUE LEVELS IN PRIMARY PREY ITEMS (Site Specific)**

CHEMICAL	AVERAGE SEDIMENT CONCENTRATION (mg/kg)	AVERAGE SURFACE WATER CONCENTRATION (mg/L)	Invertebrate Tissue Level [a] (mg/kg)	Amphibian Tissue Level [a] (mg/kg)
1,1,1-Trichloroethane	3.4E+00		NA	NA
1,1-Dichloroethane	7.5E-03		NA	NA
2,4,4-Trimethyl-1-pentene	9.8E-01	6.9E-03	NA	NA
2,4,4-Trimethyl-2-Pentene	2.9E-01	3.9E-03	NA	NA
2-Hexanone	1.7E-02		NA	NA
Acetone	1.9E-01		NA	NA
Benzene	6.3E-03		NA	NA
Carbon Disulfide	5.0E-03		NA	NA
Chlorobenzene	3.0E-03		NA	NA
Ethylbenzene	6.0E-03		NA	NA
Methylene Chloride	1.1E-02		NA	NA
Toluene	5.7E-03		NA	NA
Trichloroethene (TCE)	6.0E-03		NA	NA
Xylenes, Total	2.4E-02		NA	NA
bis(Chloromethyl)ether	4.1E-01		NA	ND
1,2,4-Trichlorobenzene	1.2E+00		ND	ND
4-Bromophenyl-phenylether	3.0E+00		ND	ND
4-Chlorophenyl-phenylether	2.0E+00		ND	ND
Benzo(b)Fluoranthene	6.4E-02		ND	ND
Benzoic Acid	5.9E-01		ND	ND
Butylbenzylphthalate	1.7E+01		ND	ND
Chrysene	1.3E+00		ND	ND
Di-n-butylphthalate	2.9E+01		ND	ND
Di-n-octylphthalate	2.4E+01	4.9E-03	ND	ND
Dimethylphthalate	5.3E-01		ND	ND
Fluoranthene	6.4E-01		ND	ND
Fluorene	9.2E-02		ND	ND
Indeno (1,2,3-cd)Pyrene	1.3E+01		ND	ND
N-Nitrosodiphenylamine (1)	7.0E+01	2.5E-03	ND	ND
Phenanthrene	4.2E+00		ND	ND
Phenol	5.8E-01	1.0E-03	8.0E-02	ND
Pyrene	9.3E-01		ND	ND
bis(2-EthylHexyl)phthalate	6.4E+03	1.8E-02	2.5E+00	1.2E+01
4,4'-DDT	5.8E-02		ND	3.7E-03
Endosulfan I	2.8E-02		ND	ND
Endosulfan Sulfate	7.4E-02		ND	9.3E-03
Endrin Aldehyde	7.0E-02		ND	2.0E-03
Heptachlor	6.0E-04		ND	ND
Heptachlor Epoxide	6.0E-03		ND	1.2E-03
Methoxychlor	2.9E-01		ND	2.2E-02
Aluminum	5.0E+03	5.0E+00	9.6E+01	9.8E+01
Antimony	2.5E+01		ND	1.8E-01
Barium	1.3E+01	2.1E-02	1.9E+01	2.1E+00
Beryllium	4.1E-01		ND	1.1E-02
Chromium	1.1E+03	5.5E-01	1.5E+01	3.2E+01
Cobalt	5.0E+00	1.0E-02	3.1E-01	1.0E-01
Copper	7.5E+00		3.4E+01	2.7E+00
Lead	1.8E+01		3.7E-01	2.4E-01

TABLE A4-7
ESTIMATION OF CHRONIC EXPOSURES TO SEMI-AQUATIC RECEPTORS VIA FOOD, WATER, AND SEDIMENT INGESTION

SOUTH DITCH - AQUATIC HABITAT
STAGE II ECOLOGICAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON MASSACHUSETTS

EXPOSURE CONCENTRATION DATA / **TISSUE LEVELS IN PRIMARY PREY ITEMS (Site Specific)**

CHEMICAL	AVERAGE SEDIMENT CONCENTRATION (mg/kg)	AVERAGE SURFACE WATER CONCENTRATION (mg/L)	Invertebrate Tissue Level [a] (mg/kg)	Amphibian Tissue Level [a] (mg/kg)
Manganese		9.0E-01	3.6E+01	1.2E+01
Mercury	2.1E-01		2.6E-02	3.6E-02
Nickel	7.3E+00		1.6E-01	1.2E-01
Silver	8.4E-01		7.2E-02	3.7E-02
Vanadium	7.4E+00		3.8E-01	2.2E-01
Zinc	3.2E+01	6.2E-02	2.8E+01	2.1E+01
Chloride	8.0E+01	1.5E+02	NA	NA
Nitrate as N	9.3E-01	6.2E+00	NA	NA
Nitrite as N		2.1E-01	NA	NA
Nitrogen, Ammonia	1.7E+02	4.5E+01	NA	NA
Sulfate as SO4	8.1E+02	3.8E+02	NA	NA

[a] Invertebrate and amphibian tissue concentrations are presented in Attachment 1, Tables A1-3 and A1-4, respectively.

NA = Not Analysed

ND = Not Detected

TABLE A4-7
RISK ESTIMATION OF SUBLETHAL EFFECTS TO SEMI-AQUATIC RECEPTORS VIA FOOD, WATER, AND SEDIMENT INGESTION

SOUTH DITCH - AQUATIC HABITAT
STAGE II ECOLOGICAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON MASSACHUSETTS

CHEMICAL	*Green heron*		
	TBD	RTV	HQ
1,1,1-Trichloroethane	2.0E-03	145.0	1.4E-05
1,1-Dichloroethane	4.5E-06	10.7	4.2E-07
2,4,4-Trimethyl-1-pentene	6.7E-04	NA	
2,4,4-Trimethyl-2-Pentene	2.2E-04	NA	
2-Hexanone	1.0E-05	61.4	1.7E-07
Acetone	1.1E-04	592.8	1.9E-07
Benzene	3.7E-06	11.9	3.2E-07
Carbon Disulfide	3.0E-06	NA	
Chlorobenzene	1.8E-06	NA	
Ethylbenzene	3.6E-06	345.0	1.0E-08
Methylene Chloride	6.6E-06	62.4	1.1E-07
Toluene	3.4E-06	528.8	6.4E-09
Trichloroethene (TCE)	3.6E-06	25.1	1.4E-07
Xylenes, Total	1.4E-05	592.8	2.4E-08
bis(Chloromethyl)ether	2.4E-04	NA	
1,2,4-Trichlorobenzene	7.1E-04	NA	
4-Bromophenyl-phenylether	1.8E-03	NA	
4-Chlorophenyl-phenylether	1.2E-03	NA	
Benzo(b)Fluoranthene	3.8E-05	42.4	9.0E-07
Benzoic Acid	3.5E-04	NA	
Butylbenzylphthalate	1.0E-02	188.5	5.4E-05
Chrysene	7.7E-04	104.9	7.4E-06
Di-n-butylphthalate	1.7E-02	148.2	1.2E-04
Di-n-octylphthalate	1.4E-02	207.5	6.9E-05
Dimethylphthalate	3.2E-04	3746.6	8.4E-08
Fluoranthene	3.8E-04	130.7	2.9E-06
Fluorene	5.5E-05	130.7	4.2E-07
Indeno (1,2,3-cd)Pyrene	7.7E-03	76.3	1.0E-04
N-Nitrosodiphenylamine (1)	4.2E-02	39.1	1.1E-03
Phenanthrene	2.5E-03	142.3	1.8E-05
Phenol	8.3E-04	142.3	5.8E-06
Pyrene	5.5E-04	65.3	8.5E-06
bis(2-EthylHexyl)phthalate	3.9E+00	30.6	1.3E-01
4,4'-DDT	5.4E-05	0.2	3.0E-04
Endosulfan I	1.7E-05	0.1	1.2E-04
Endosulfan Sulfate	9.4E-05	0.1	6.9E-04
Endrin Aldehyde	5.2E-05	0.3	1.9E-04
Heptachlor	3.6E-07	0.4	8.6E-07
Heptachlor Epoxide	1.0E-05	0.4	2.4E-05
Methoxychlor	2.9E-04	71.1	4.1E-06
Aluminum	4.2E+00	222.2	1.9E-02
Antimony	1.6E-02	49.6	3.2E-04
Barium	1.4E-01	107.9	1.3E-03
Beryllium	4.2E-04	1.0	4.2E-04
Chromium	8.9E-01	362.5	2.5E-03
Cobalt	5.3E-03	15.4	3.5E-04
Copper	2.2E-01	52.3	4.2E-03
Lead	1.4E-02	8.6	1.6E-03

TABLE A4-7
RISK ESTIMATION OF SUBLETHAL EFFECTS TO SEMI-AQUATIC RECEPTORS VIA FOOD, WATER, AND SEDIMENT INGESTION

SOUTH DITCH - AQUATIC HABITAT
STAGE II ECOLOGICAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON MASSACHUSETTS

CHEMICAL	*Green heron*		
	TBD	RTV	HQ
Manganese	2.8E-01	118.6	2.3E-03
Mercury	4.7E-04	0.4	1.2E-03
Nickel	6.7E-03	8.7	7.7E-04
Silver	1.8E+00	NA	
Vanadium	8.2E-02	19.4	4.2E-03
Zinc	3.0E-01	237.1	1.3E-03
Chloride	5.8E-01	NA	
Nitrate as N	4.5E+00	NA	
Nitrite as N	0.0E+00	NA	
Nitrogen, Ammonia	1.0E-01	NA	
Sulfate as SO4	4.8E-01	NA	
SUMMARY HAZARD INDEX			1.7E-01

TBD = Total Body Dose (mg/kgBW-day).
RTV = Reference Toxicity Value (mg/kgBW-day); wildlife RTVs are presented in Table A4-3.
HQ = Hazard Quotient (calculated by dividing TBD by RTV)
NA = Not Available

TABLE A4-7
RISK ESTIMATION OF SUBLETHAL EFFECTS TO SEMI-AQUATIC RECEPTORS VIA FOOD, WATER, AND SEDIMENT INGESTION

SOUTH DITCH - AQUATIC HABITAT
STAGE II ECOLOGICAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON MASSACHUSETTS

TOTAL BODY DOSE (mg/kgBW-day) [b]

CHEMICAL	*Green heron*
1,1,1-Trichloroethane	2.0E-03
1,1-Dichloroethane	4.5E-06
2,4,4-Trimethyl-1-pentene	6.7E-04
2,4,4-Trimethyl-2-Pentene	2.2E-04
2-Hexanone	1.0E-05
Acetone	1.1E-04
Benzene	3.7E-06
Carbon Disulfide	3.0E-06
Chlorobenzene	1.8E-06
Ethylbenzene	3.6E-06
Methylene Chloride	6.6E-06
Toluene	3.4E-06
Trichloroethene (TCE)	3.6E-06
Xylenes, Total	1.4E-05
bis(Chloromethyl)ether	2.4E-04
1,2,4-Trichlorobenzene	7.1E-04
4-Bromophenyl-phenylether	1.8E-03
4-Chlorophenyl-phenylether	1.2E-03
Benzo(b)Fluoranthene	3.8E-05
Benzoic Acid	3.5E-04
Butylbenzylphthalate	1.0E-02
Chrysene	7.7E-04
Di-n-butylphthalate	1.7E-02
Di-n-octylphthalate	1.4E-02
Dimethylphthalate	3.2E-04
Fluoranthene	3.8E-04
Fluorene	5.5E-05
Indeno (1,2,3-cd)Pyrene	7.7E-03
N-Nitrosodiphenylamine (1)	4.2E-02
Phenanthrene	2.5E-03
Phenol	8.3E-04
Pyrene	5.5E-04
bis(2-EthylHexyl)phthalate	3.9E+00
4,4'-DDT	5.4E-05
Endosulfan I	1.7E-05
Endosulfan Sulfate	9.4E-05
Endrin Aldehyde	5.2E-05
Heptachlor	3.6E-07
Heptachlor Epoxide	1.0E-05
Methoxychlor	2.9E-04
Aluminum	4.2E+00
Antimony	1.6E-02
Barium	1.4E-01
Beryllium	4.2E-04
Chromium	8.9E-01
Cobalt	5.3E-03
Copper	2.2E-01
Lead	1.4E-02

TABLE A4-7
RISK ESTIMATION OF SUBLETHAL EFFECTS TO SEMI-AQUATIC RECEPTORS VIA FOOD, WATER, AND SEDIMENT INGESTION

SOUTH DITCH - AQUATIC HABITAT
STAGE II ECOLOGICAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON MASSACHUSETTS

TOTAL BODY DOSE (mg/kgBW-day) [b]

CHEMICAL	*Green heron*
Manganese	2.8E-01
Mercury	4.7E-04
Nickel	6.7E-03
Silver	1.8E+00
Vanadium	8.2E-02
Zinc	3.0E-01
Chloride	5.8E-01
Nitrate as N	4.5E+00
Nitrite as N	0.0E+00
Nitrogen, Ammonia	1.0E-01
Sulfate as SO4	4.8E-01

[b] Calculated by summing the products of individual prey type concentrations and percent in diet surface water and sediment exposures, multiplying by the exposure duration, SFF and ingestion rat and dividing by body weight.

TABLE A4-7

ESTIMATION OF CHRONIC EXPOSURES TO SEMI-AQUATIC RECEPTORS VIA FOOD, WATER, AND SEDIMENT INGESTION

SOUTH DITCH - AQUATIC HABITAT
STAGE II ECOLOGICAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON MASSACHUSETTS

EXPOSURE PARAMETERS [c]

Indicator Species		Percent Prey in Diet: Amphibian	Inverts	Plants	Sediment	Home Rang (acres)	ED [d]	Site Foraging Frequency [e]	Dietary Ingestion Rate (kg/day)	Water Ingestion Rate (L/day)	Body Weight (kg)
Green heron	(Carn. bird)	50%	45%	0%	5%	1	0.5	2.40E-01	0.021	0.021	0.21

SITE AREA: 0.24 acres

NOTES:

[c] Documentation of exposure parameters presented in Attachment 4, Table A4-1.

[d] ED = Exposure Duration (percentage of year receptor is expected to be found at study area)

[e] SFF = Site Foraging Frequency (calculated by dividing site area by receptor home range (cannot exceed 1.0))

TABLE A4-8
ESTIMATION OF CHRONIC EXPOSURES TO SEMI-AQUATIC RECEPTORS VIA FOOD, WATER, AND SEDIMENT INGESTION

EPHEMERAL DITCH - AQUATIC HABITAT
STAGE II ECOLOGICAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON MASSACHUSETTS

EXPOSURE CONCENTRATION DATA / TISSUE LEVELS IN PRIMARY PREY ITEMS (Site Specific)

CHEMICAL	AVERAGE SEDIMENT CONCENTRATION (mg/kg)	AVERAGE SURFACE WATER CONCENTRATION (mg/L)	Invertebrate Tissue Level [a] (mg/kg)	Amphibian Tissue Level [a] (mg/kg)
2,4,4-Trimethyl-1-pentene	4.0E-03		NA	NA
Acetone	7.0E-03		NA	NA
Methylene Chloride	1.2E-02		NA	NA
Toluene	3.5E-03		NA	NA
Xylenes, Total	3.9E-03		NA	NA
Benzo(a)Anthracene	9.5E-02		ND	ND
Benzo(b)Fluoranthene	1.8E-01		ND	ND
Benzo(g,h,i)Perylene	8.3E-02		ND	ND
Chrysene	1.4E-01		ND	ND
Di-n-octylphthalate		5.3E-03	ND	ND
Fluoranthene	2.1E-01		ND	ND
Indeno (1,2,3-cd)Pyrene	9.1E-02		ND	ND
Phenanthrene	1.3E-01		ND	ND
Pyrene	1.7E-01		ND	ND
bis(2-EthylHexyl)phthalate	1.8E+00	4.7E-03	2.5E+00	1.2E+01
Aluminum	5.3E+03	9.4E+00	9.6E+01	9.8E+01
Arsenic		8.5E-02	2.4E-01	1.6E-01
Barium	1.1E+01	3.8E-02	1.9E+01	2.1E+00
Chromium	1.2E+01	4.8E-02	1.5E+01	3.2E+01
Cobalt	2.2E+00	1.2E-02	3.1E-01	1.0E-01
Copper	4.5E+00		3.4E+01	2.7E+00
Lead	1.2E+01	6.2E-02	3.7E-01	2.4E-01
Manganese		7.0E-01	3.6E+01	1.2E+01
Mercury		4.0E-04	2.6E-02	3.6E-02
Nickel	3.1E+00		1.6E-01	1.2E-01
Selenium	5.1E-01		3.5E-01	3.4E-01
Silver	1.7E+00		7.2E-02	3.7E-02
Vanadium	7.7E+00	7.2E-02	3.8E-01	2.2E-01
Zinc	8.4E+00	7.4E-02	2.8E+01	2.1E+01
Chloride		1.8E+01	NA	NA
Nitrogen, Ammonia	3.2E+01	1.0E+00	NA	NA
Sulfate as SO4	1.5E+02	2.2E+02	NA	NA

[a] Invertebrate and amphibian tissue concentrations are presented in Attachment 1, Tables A1-3 and A1-4, respectively.
NA = Not Analysed
ND = Not Detected

TABLE A4-8
RISK ESTIMATION OF SUBLETHAL EFFECTS TO SEMI-AQUATIC RECEPTORS VIA FOOD, WATER, AND SEDIMENT INGESTION

EPHEMERAL DITCH - AQUATIC HABITAT
STAGE II ECOLOGICAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON MASSACHUSETTS

CHEMICAL	*Green heron*		
	TBD	RTV	HQ
2,4,4-Trimethyl-1-pentene	2.8E-06	NA	
Acetone	4.9E-06	5.9E+02	8.2E-09
Methylene Chloride	8.1E-06	6.2E+01	1.3E-07
Toluene	2.4E-06	5.3E+02	4.6E-09
Xylenes, Total	2.7E-06	5.9E+02	4.6E-09
Benzo(a)Anthracene	6.6E-05	2.1E+00	3.1E-05
Benzo(b)Fluoranthene	1.2E-04	4.2E+01	2.9E-06
Benzo(g,h,i)Perylene	5.8E-05	1.0E+02	5.5E-07
Chrysene	9.7E-05	1.0E+02	9.3E-07
Di-n-octylphthalate	7.4E-05	2.1E+02	3.5E-07
Fluoranthene	1.5E-04	1.3E+02	1.1E-06
Indeno (1,2,3-cd)Pyrene	6.3E-05	7.6E+01	8.3E-07
Phenanthrene	9.0E-05	1.4E+02	6.3E-07
Pyrene	1.2E-04	6.5E+01	1.8E-06
bis(2-EthylHexyl)phthalate	9.4E-02	3.1E+01	3.1E-03
Aluminum	5.1E+00	2.2E+02	2.3E-02
Arsenic	3.8E-03	5.0E+01	7.8E-05
Barium	1.5E-01	1.1E+02	1.4E-03
Chromium	3.1E-01	3.6E+02	8.6E-04
Cobalt	4.5E-03	1.5E+01	2.9E-04
Copper	2.6E-01	5.2E+01	4.9E-03
Lead	1.4E-02	8.6E+00	1.6E-03
Manganese	3.3E-01	1.2E+02	2.8E-03
Mercury	4.1E-04	4.0E-01	1.0E-03
Nickel	4.0E-03	8.7E+00	4.6E-04
Selenium	4.9E-03	1.3E+00	3.8E-03
Silver	1.9E-03	NA	
Vanadium	1.0E-02	1.9E+01	5.3E-04
Zinc	3.3E-01	2.4E+02	1.4E-03
Chloride	2.5E-01	NA	
Nitrogen, Ammonia	3.6E-02	NA	
Sulfate as SO4	3.1E+00	NA	
SUMMARY HAZARD INDEX			4.5E-02

TBD = Total Body Dose (mg/kgBW-day).
RTV = Reference Toxicity Value (mg/kgBW-day); wildlife RTVs are presented in Table A4-7.
HQ = Hazard Quotient (calculated by dividing TBD by RTV)
NA = Not Available

TABLE A4-8
RISK ESTIMATION OF SUBLETHAL EFFECTS TO SEMI-AQUATIC RECEPTORS VIA FOOD, WATER, AND SEDIMENT INGESTION

EPHEMERAL DITCH - AQUATIC HABITAT
STAGE II ECOLOGICAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON MASSACHUSETTS

TOTAL BODY DOSE (mg/kgBW-day) [b]

CHEMICAL	*Green heron*
2,4,4-Trimethyl-1-pentene	2.8E-06
Acetone	4.9E-06
Methylene Chloride	8.1E-06
Toluene	2.4E-06
Xylenes, Total	2.7E-06
Benzo(a)Anthracene	6.6E-05
Benzo(b)Fluoranthene	1.2E-04
Benzo(g,h,i)Perylene	5.8E-05
Chrysene	9.7E-05
Di-n-octylphthalate	7.4E-05
Fluoranthene	1.5E-04
Indeno (1,2,3-cd)Pyrene	6.3E-05
Phenanthrene	9.0E-05
Pyrene	1.2E-04
bis(2-EthylHexyl)phthalate	9.4E-02
Aluminum	5.1E+00
Arsenic	3.8E-03
Barium	1.5E-01
Chromium	3.1E-01
Cobalt	4.5E-03
Copper	2.6E-01
Lead	1.4E-02
Manganese	3.3E-01
Mercury	4.1E-04
Nickel	4.0E-03
Selenium	4.9E-03
Silver	1.9E-03
Vanadium	1.0E-02
Zinc	3.3E-01
Chloride	2.5E-01
Nitrogen, Ammonia	3.6E-02
Sulfate as SO4	3.1E+00

[b] Calculated by summing the products of individual prey type concentrations and percent in diet surface water and sediment exposures, multiplying by the exposure duration, SFF and ingestion rate and dividing by body weight.

TABLE A4-8
ESTIMATION OF CHRONIC EXPOSURES TO SEMI-AQUATIC RECEPTORS VIA FOOD, WATER, AND SEDIMENT INGESTION

EPHEMERAL DITCH - AQUATIC HABITAT
STAGE II ECOLOGICAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON MASSACHUSETTS

EXPOSURE PARAMETERS [c]

Indicator Species		Percent Prey in Diet Amphibian	Inverts	Plants	Sediment	Home Range (acres)	ED [d]	Site Foraging Frequency [e]	Dietary Ingestion Rate (kg/day)	Water Ingestion Rate (L/day)	Body Weight (kg)
Green heron	(Carn. bird)	50%	45%	0%	5%	1	0.5	2.80E-01	0.021	0.021	0.21

SITE AREA:	0.28	acres

NOTES:

[c] Documentation of exposure parameters presented in Attachment 4, Table A4-1.

[d] ED = Exposure Duration (percentage of year receptor is expected to be found at study area)

[e] SFF = Site Foraging Frequency (calculated by dividing site area by receptor home range (cannot exceed 1.0))

TABLE A4-9
ESTIMATION OF CHRONIC EXPOSURES TO SEMI-AQUATIC RECEPTORS VIA FOOD, WATER, AND SEDIMENT INGESTION

CENTRAL POND - AQUATIC HABITAT
STAGE II ECOLOGICAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON MASSACHUSETTS

EXPOSURE CONCENTRATION DATA / **TISSUE LEVELS IN PRIMARY PREY ITEMS (Site Specific)**

CHEMICAL	AVERAGE SEDIMENT CONCENTRATION (mg/kg)	AVERAGE SURFACE WATER CONCENTRATION (mg/L)	Invertebrate Tissue Level [a] (mg/kg)	Amphibian Tissue Level [a] (mg/kg)
1,1-Dichloroethane	1.4E-02	NA	NA	NA
2,4,4-Trimethyl-1-pentene	1.2E+01	NA	NA	NA
2,4,4-Trimethyl-2-Pentene	1.8E+00	NA	NA	NA
Acetone	5.5E-02	NA	NA	NA
Methylene Chloride	2.2E-02	NA	NA	NA
Xylenes, Total	3.3E-02	NA	NA	NA
4-Bromophenyl-phenylether	3.4E+00	NA	ND	ND
4-Chlorophenyl-phenylether	2.3E+00	NA	ND	ND
Di-n-butylphthalate	1.5E+01	NA	ND	ND
Di-n-octylphthalate	1.2E+00	NA	ND	ND
N-Nitrosodiphenylamine (1)	1.9E+01	NA	ND	ND
bis(2-EthylHexyl)phthalate	2.4E+03	NA	2.5E+00	1.2E+01
Aldrin	1.0E-01	NA	ND	1.2E-03
Alpha-Chlordane	2.5E-02	NA	ND	1.3E-03
Endrin	3.5E-02	NA	ND	2.1E-03
Aluminum	2.5E+04	NA	9.6E+01	9.8E+01
Antimony	2.2E+01	NA	ND	1.8E-01
Barium	4.0E+01	NA	1.9E+01	2.1E+00
Beryllium	3.6E+00	NA	ND	1.1E-02
Cadmium	1.2E+00	NA	5.3E-02	1.6E-01
Chromium	7.4E+03	NA	1.5E+01	3.2E+01
Cobalt	1.6E+01	NA	3.1E-01	1.0E-01
Copper	5.6E+01	NA	3.4E+01	2.7E+00
Lead	3.3E+01	NA	3.7E-01	2.4E-01
Mercury	4.5E-01	NA	2.6E-02	3.6E-02
Nickel	4.1E+01	NA	1.6E-01	1.2E-01
Thallium	2.1E+00	NA	1.1E-01	ND
Vanadium	3.3E+01	NA	3.8E-01	2.2E-01
Zinc	1.3E+02	NA	2.8E+01	2.1E+01
Nitrogen, Ammonia	1.6E+02	NA	NA	NA

[a] Invertebrate and amphibian tissue concentrations are presented in Attachment 1, Tables A1-3 and A1-4, respectively.
NA = Not Analysed
ND = Not Detected

TABLE A4-9
RISK ESTIMATION OF SUBLETHAL EFFECTS TO SEMI-AQUATIC RECEPTORS VIA FOOD, WATER, AND SEDIMENT INGESTION

CENTRAL POND - AQUATIC HABITAT
STAGE II ECOLOGICAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON MASSACHUSETTS

CHEMICAL	Green heron		
	TBD	RTV	HQ
1,1-Dichloroethane	5.9E-06	1.1E+01	5.5E-07
2,4,4-Trimethyl-1-pentene	5.1E-03	NA	
2,4,4-Trimethyl-2-Pentene	7.6E-04	NA	
Acetone	2.3E-05	5.9E+02	3.9E-08
Methylene Chloride	9.3E-06	6.2E+01	1.5E-07
Xylenes, Total	1.4E-05	5.9E+02	2.3E-08
4-Bromophenyl-phenylether	1.4E-03	NA	
4-Chlorophenyl-phenylether	9.7E-04	NA	
Di-n-butylphthalate	6.5E-03	1.5E+02	4.4E-05
Di-n-octylphthalate	5.1E-04	2.1E+02	2.4E-06
N-Nitrosodiphenylamine (1)	8.0E-03	3.9E+01	2.1E-04
bis(2-EthylHexyl)phthalate	1.1E+00	3.1E+01	3.5E-02
Aldrin	4.8E-05	3.4E-01	1.4E-04
Alpha-Chlordane	1.5E-05	1.4E-01	1.1E-04
Endrin	2.3E-05	2.8E-01	8.2E-05
Aluminum	1.1E+01	2.2E+02	5.1E-02
Antimony	1.0E-02	5.0E+01	2.0E-04
Barium	1.0E-01	1.1E+02	9.7E-04
Beryllium	1.6E-03	1.0E+00	1.6E-03
Cadmium	1.3E-03	6.6E+00	2.0E-04
Chromium	3.3E+00	3.6E+02	9.1E-03
Cobalt	8.5E-03	1.5E+01	5.5E-04
Copper	1.8E-01	5.2E+01	3.4E-03
Lead	1.6E-02	8.6E+00	1.9E-03
Mercury	4.4E-04	4.0E-01	1.1E-03
Nickel	1.8E-02	8.7E+00	2.1E-03
Thallium	1.3E-03	2.3E+00	5.9E-04
Vanadium	1.6E-02	1.9E+01	8.4E-04
Zinc	2.5E-01	2.4E+02	1.1E-03
Nitrogen, Ammonia	6.6E-02	NA	
SUMMARY HAZARD INDEX			1.1E-01

TBD = Total Body Dose (mg/kgBW-day).
RTV = Reference Toxicity Value (mg/kgBW-day); wildlife RTVs presented in Table A4-3.
HQ = Hazard Quotient (calculated by dividing TBD by RTV)
NA = Not Available

TABLE A4-9
ESTIMATION OF CHRONIC EXPOSURES TO SEMI-AQUATIC RECEPTORS
VIA FOOD, WATER, AND SEDIMENT INGESTION

CENTRAL POND - AQUATIC HABITAT
STAGE II ECOLOGICAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON MASSACHUSETTS

TOTAL BODY DOSE (mg/kgBW-day) [b]

CHEMICAL	*Green heron*
1,1-Dichloroethane	5.9E-06
2,4,4-Trimethyl-1-pentene	5.1E-03
2,4,4-Trimethyl-2-Pentene	7.6E-04
Acetone	2.3E-05
Methylene Chloride	9.3E-06
Xylenes, Total	1.4E-05
4-Bromophenyl-phenylether	1.4E-03
4-Chlorophenyl-phenylether	9.7E-04
Di-n-butylphthalate	6.5E-03
Di-n-octylphthalate	5.1E-04
N-Nitrosodiphenylamine (1)	8.0E-03
bis(2-EthylHexyl)phthalate	1.1E+00
Aldrin	4.8E-05
Alpha-Chlordane	1.5E-05
Endrin	2.3E-05
Aluminum	1.1E+01
Antimony	1.0E-02
Barium	1.0E-01
Beryllium	1.6E-03
Cadmium	1.3E-03
Chromium	3.3E+00
Cobalt	8.5E-03
Copper	1.8E-01
Lead	1.6E-02
Mercury	4.4E-04
Nickel	1.8E-02
Thallium	1.3E-03
Vanadium	1.6E-02
Zinc	2.5E-01
Nitrogen, Ammonia	6.6E-02

[b] Calculated by summing the products of individual prey type concentrations and percent in diet with surface water and sediment exposures, multiplying by the exposure duration, SFF and ingestion rate, and dividing by body weight

TABLE A4-9
ESTIMATION OF CHRONIC EXPOSURES TO SEMI-AQUATIC RECEPTORS VIA FOOD, WATER, AND SEDIMENT INGESTION

CENTRAL POND - AQUATIC HABITAT
STAGE II ECOLOGICAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON MASSACHUSETTS

EXPOSURE PARAMETERS [c]

Indicator Species		Percent Prey in Diet: Amphibians	Inverts	Plants	Sediment	Home Rang (acres)	ED [d]	Site Foraging Frequency [e]	Dietary Ingestion Rate (kg/day)	Water Ingestion Rate (L/day)	Body Weight (kg)
Green heron	(Carn. bird	50%	45%	0%	5%	1	0.5	1.70E-01	0.021	0.021	0.21

SITE AREA: 0.17 acres

NOTES:

[c] Documentation of exposure parameters presented in Attachment 4, Table A4-1.

[d] ED = Exposure Duration (percentage of year receptor is expected to be found at study area)

[e] SFF = Site Foraging Frequency (calculated by dividing site area by receptor home range (cannot exceed 1.0))

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ATTACHMENT #5

POPULATION MODEL

LANGHEI
ECOLOGY

Sediment Toxicity Evaluation:
Population-level Effects on a *Ranid* Frog

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Background

Most anurans, including the green frog (*Rana clamitans*), exhibit a Type III survivorship curve characterized by high mortality early in life, and low, relatively constant mortality later in life. In the case of anurans, the transition from relatively high to low mortality occurs at metamorphosis. Mortality during the larval stage is strongly density dependent, whereas it is largely density independent in juveniles and adults (Berven 1990, Wilbur 1976). Population-level effects of toxicity can be strongly influenced by the timing of exposure and mortality relative to density dependent survivorship. The Sediment Toxicity Evaluation based on a series of 96-hour FETAX assays with larval African clawed frogs (*Xenopus laevis*)[1] demonstrated toxic effects early in the larval stage (i.e. on eggs); thus, the potential exists for compensatory reductions in natural mortality.

This report briefly describes a model of the potential effects of soil and sediment contamination on the abundance of green frogs (*Rana clamitans*) at the Olin Chemical Company site in Wilmington, Massachusetts. The model is designed to support an evaluation of potential population-level effects based on the results of the sediment toxicity evaluation. The model is a simple, age-structured population model that incorporates density-dependent mortality during the larval stage and density-independent mortality during the juvenile and adult life stages. Implicit in the model structure is the assumption that the toxicity applies across the entire population of larvae, but that only the eggs are exposed to toxic levels of contamination.

Model Description

The abundance of frogs in each age class is calculated iteratively on an annual time step using life history and demographic information obtained from published literature (Table 1). The larval and juvenile stages are each assumed to last one year (Ryan 1953). Starting from arbitrary initial abundances for each age class, the number of frogs in each age class in the next year is calculated as follows:

$$N_{x+1,t+1} = N_{x,t} S_x \qquad x = 0, 1, 2, \ldots, 6$$

where $N_{x,t}$ is the number of frogs in age class x in year t, and S_x is the survival from age x to age $x+1$. (Age is years post-metamorphosis.)

The total number of adults is calculated as:

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[1]*Toxicological Evaluation of Sediment and Soil Samples: Olin Chemical Company Site. January 1997.* Prepared for: ABB-Environmental Services, Incorporated. Prepared by: EnviroSystems, Incorporated. Reference Number ABB6244-97-01.

$$ADULTS_t = \sum_{x=1}^{6} N_{x,t}$$

The number of eggs deposited in year t ($EGGS_t$) is the product of the average number of clutches per female (C), average clutch size (M), fraction of the adult population that is females (F), and total adult abundance ($ADULTS_t$):

$$EGGS_t = C\ M\ F\ ADULTS_t$$

The number of larvae surviving to metamorphosis the following year ($N_{0,t+1}$) is a function of the number of eggs deposited ($EGGS_t$), larval survival at low density (S_L), toxicity (TOX), and a density dependence term with parameter (β). The density dependence term takes one of two forms, depending on whether toxicity is assumed to operate before (a) or after (b) density dependence:

$$N_{0,t+1} = EGGS_t\ (1-TOX)\ S_L\ e^{-\beta\ EGGS_t\ (1-TOX)} \qquad (a)$$
$$N_{0,t+1} = EGGS_t\ (1-TOX)\ S_L\ e^{-\beta\ EGGS_t} \qquad (b)$$

Table 1 lists the model parameters, their values, and sources for the values used. Some of the parameter values are for the wood frog (*Rana sylvatica*), because the requisite information was not found for *R. clamitans*. The model is parameterized to yield abundances on a ha.$^{-1}$ basis. The model was run using larval toxicities ranging from 0 to 100% mortality. Each simulation ran for 100 years.

Table 1. Variables and parameters for the Ranid population model.

Parameter	Symbol	Value	Source
Fraction of adult population that is females	F	0.25	Berven (1990) (wood frog)
Average clutch size	M	4,100	Martof (1956)
Average number of clutches each year per female	C	1.45	Wells (1976)
Larval survival at low density	S_L	0.08	Berven (1990) (wood frog) Maximum observed larval survival.
Age-specific survival	S_0 S_1 S_2 S_3 S_4 S_5	0.23	Shirose and Brooks (1995)
Density dependence parameter	β	9.38×10^{-7}	Wilbur (1976) (wood frog) Normalized to ha.$^{-1}$
Toxicity induced mortality	TOX	0.0 - 1.0	N/A

Variable	Symbol	Initial Value
Eggs deposited in year t	$EGGS_t$	0.0
Age-specific abundance (ha.$^{-1}$) in year t	$N_{0,t}$	0.0
	$N_{1,t}$	100.0
	$N_{2,t}$	12.0
	$N_{3,t}$	12.0
	$N_{4,t}$	9.6
	$N_{5,t}$	5.8
	$N_{6,t}$	0.6

RESULTS

In the absence of sediment toxicity on the larval stage, the population shows strong oscillations (Figure 1, top row, left column). This is a consequence of the high reproductive potential and strong density dependent survival in the larvae coupled with the time lag between egg deposition and recruitment to the breeding population. Increasing mortality prior to density dependent population regulation decreases the population growth rate, which damps the oscillations and allows the population to maintain a higher average abundance (left column, middle rows). When the toxicity level is very high (survival = 1.5%), the population grows very slowly and does not reach equilibrium within 100 years. When toxic effects occur after density dependence, however, the effect of a given larval mortality is greater and average abundance is lower (right column).

Mean abundance over 100-year simulations for the full range of toxic induced mortalities is shown in Figure 2. With toxicity occurring before density dependence operates, average abundance is greater for all but the highest levels of toxicity (Figure 2, top curve). Even under the assumption that toxicity occurs entirely after density dependent mortality in the larvae, the percent reduction in population size is less than the toxicity induced percent mortality (except for survival rates below 2.5%). For example, FETAX test survival of 20% leads to a mean population size of slightly more than 40% of the baseline. Average abundance is very sensitive to toxicity induced mortalities above 95%, and above 97.5% mortality (less than 2.5% survival) average abundance falls below baseline levels regardless of the assumption of when density dependence operates.

UNCERTAINTIES AND INTERPRETATION

The sensitivity of the model to the parameter values has not been formally examined, so the robustness of these results is unknown. Judging from Figure 2, however, abundance appears to be rather insensitive to survival rate except at survival values below 5%. This region of the graph is particularly relevant to the Olin site, because some of the sediment samples exhibited % survival x % normal development rates of 10% or less.

In the field, frog larvae would be exposed to toxic pond conditions from the time of egg deposition through metamorphosis. The FETAX tests demonstrated a toxic response in eggs, yet density dependent compensation in survivorship is related to tadpole density (Wilbur 1976). Given the assumptions of the model, this suggests that the upper curve in Figure 2 may be more appropriate for projecting population-level effects from the FETAX test results.

Regardless of the magnitude and timing of density dependent compensatory mechanisms, toxicity induced mortality will reduce the intrinsic rate of population increase (i.e. maximum growth rate at low population size) and thereby reduce the ability of the population to recover from catastrophic environmental variability (e.g. premature drying of breeding ponds) and other natural and anthropogenic stresses. The effect of lowered survival on the rate of population growth can be seen in Figure 1 (especially in the left column).

Toxicity over the range of breeding sites is more relevant to population-level effects than is toxicity of point samples. A spatially integrated or spatially explicit assessment could address this issue. Parameter uncertainty, as well as temporal and spatial environmental variability, could be taken into account within this modeling framework, but was outside of the scope of the project.

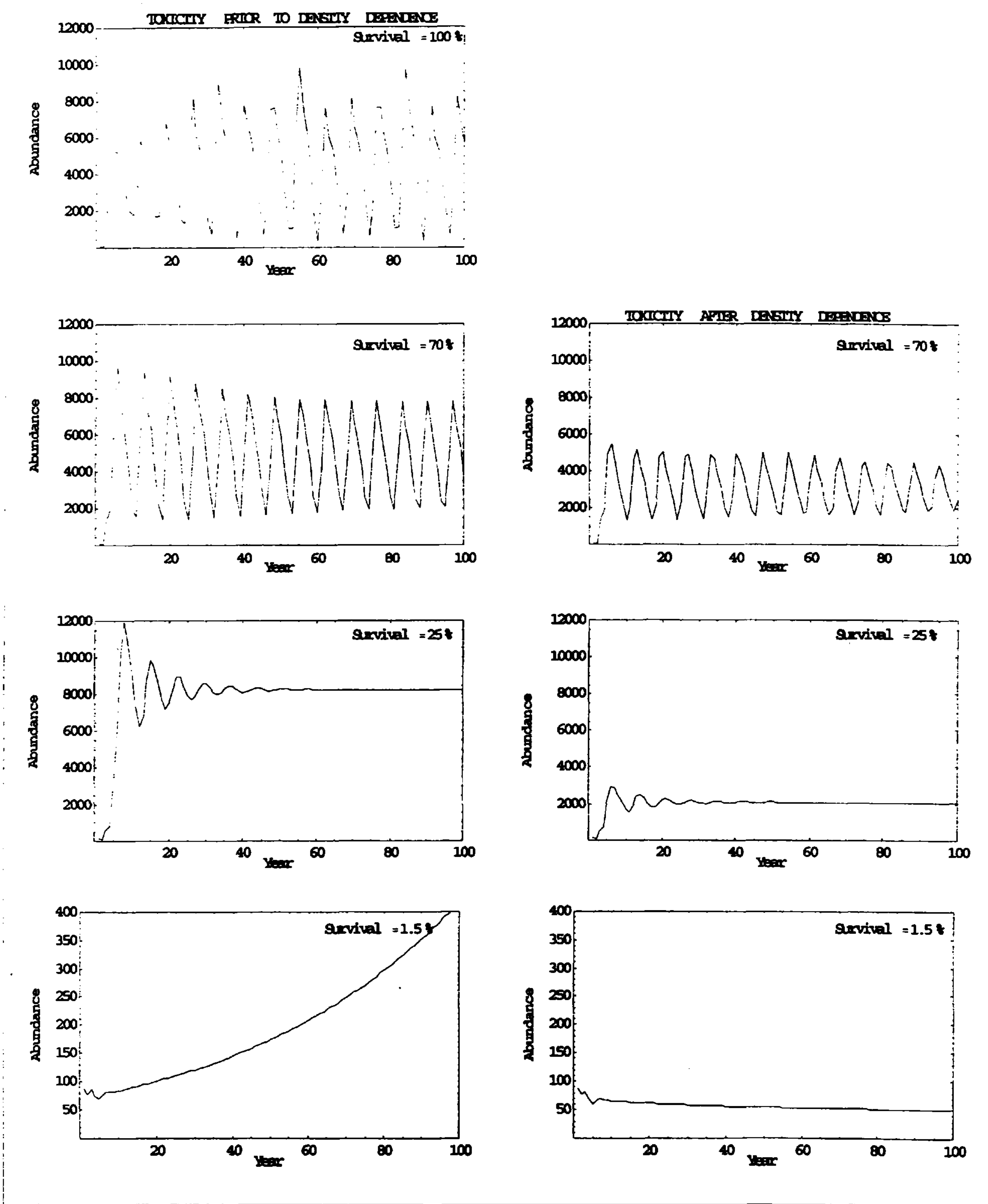

Figure 2. One hundred year simulations of adult abundance (no./ha.). The individual simulations represent toxicity before density dependence occurs (left column) and after density dependence occurs (right column). Toxicity values increase from top to bottom.

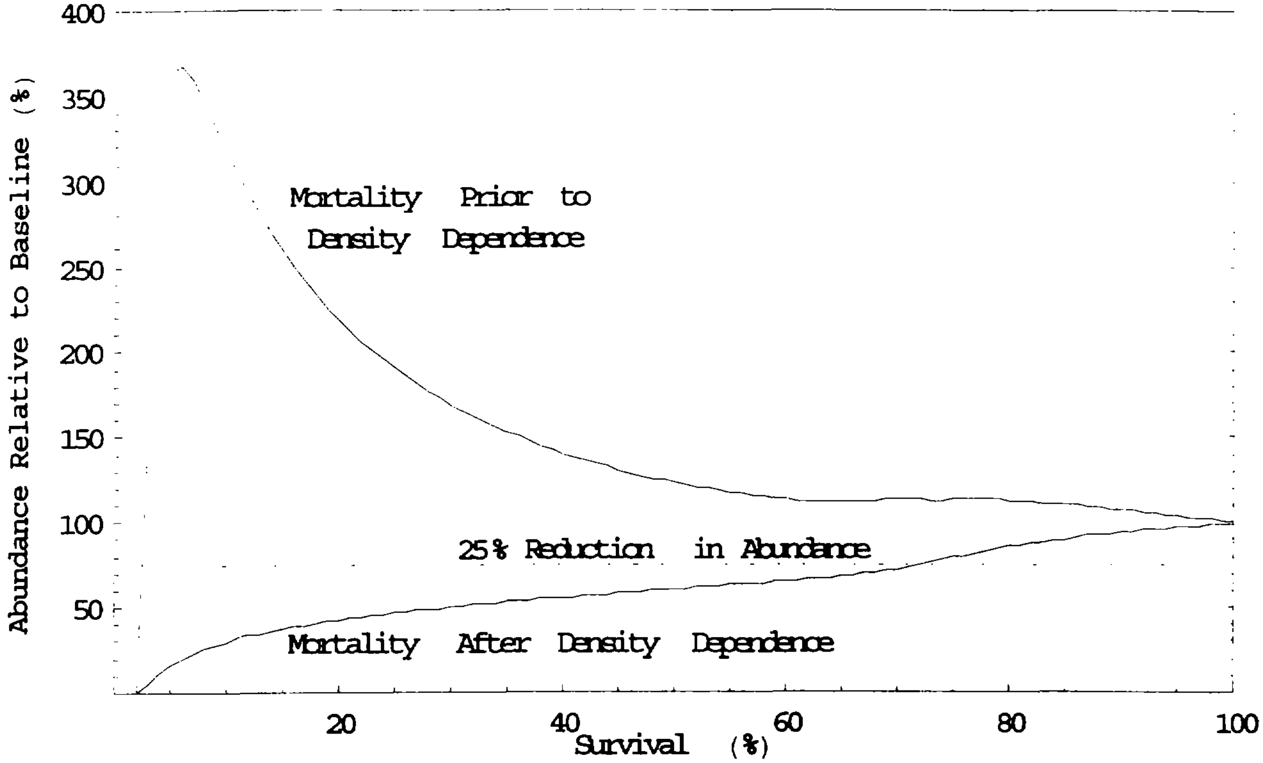

Figure 3. Population-level response to sediment toxicity. Horizontal axis is percent survival in bioassay. Vertical axis is mean abundance of adults as a percentage of the baseline (100% survival). In the upper curve, toxicity occurs before density dependence, and in the lower curve, toxicity occurs after density dependence. All simulations are 100 years.

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ATTACHMENT #6

SURFACE SOIL EXPOSURE POINT CONCENTRATIONS

TABLE A6-1
SURFACE SOIL EXPOSURE POINT CONCENTRATIONS - [Area A01]

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

	Site Data/Concentration [2]						
OHM of Concern [1]	Minimum SQL	Maximum SQL	Frequency of Detection	Minimum	Maximum	Arithmetic Mean	EPC [3]
VOCs (mg/Kg)							
1,1,1-Trichloroethane	0.005 :	0.016	4 / 9	0.01	0.23	0.0316	0.0316
1,1-Dichloroethene	0.005 :	0.016	1 / 9	0.018	0.018	0.0055	0.0055
Acetone	0.014 :	0.025	5 / 9	0.005	0.036	0.0161	0.0161
Methylene Chloride	0.005 :	0.032	3 / 9	0.002	0.007	0.0064	0.0064
Tetrachloroethene (PCE)	0.005 :	0.0085	1 / 9	0.001	0.001	0.0032	0.001
Toluene	0.005 :	0.008	3 / 9	0.001	0.013	0.0041	0.0041
SVOCs (mg/Kg)							
Anthracene	0.39 :	32	1 / 6	0.035	0.035	3.1717	0.035
Benzo(a)Anthracene	0.39 :	32	1 / 6	0.099	0.099	3.5073	0.099
Benzo(a)Pyrene	0.39 :	32	1 / 6	0.059	0.059	3.5007	0.059
Benzo(b)Fluoranthene	0.39 :	32	1 / 6	0.18	0.18	3.5208	0.18
Benzo(k)Fluoranthene	0.39 :	32	1 / 6	0.065	0.065	3.5017	0.065
Chrysene	0.39 :	32	1 / 6	0.17	0.17	3.5192	0.17
Di-n-butylphthalate	1.1 :	1.1	4 / 5	0.027	0.4	0.2642	0.2642
Diethylphthalate	1.1 :	32	2 / 6	0.044	0.085	3.1548	0.085
Fluoranthene	0.39 :	32	2 / 6	0.081	0.25	3.1293	0.25
Indeno (1,2,3-cd)Pyrene	0.39 :	32	1 / 6	0.064	0.064	3.5015	0.064
N-Nitrosodiphenylamine (1)	0.39 :	2.2	2 / 5	0.55	2.8	1.039	1.039
Phenanthrene	0.39 :	32	2 / 6	0.14	0.16	3.1242	0.16
Pyrene	0.39 :	32	2 / 6	0.085	0.16	3.1233	0.16
bis(2-EthylHexyl)phthalate			5 / 5	0.13	200	51.406	51.406
Pesticides/PCBs (mg/Kg)							
4,4'-DDE	0.0038 :	0.1	1 / 6	0.0037	0.0037	0.0236	0.0037
4,4'-DDT	0.0038 :	0.1	2 / 6	0.0016	1.7	0.3021	0.3021
Aldrin	0.002 :	0.052	1 / 6	0.0001	0.0001	0.0117	0.0001
Alpha-BHC	0.002 :	0.052	1 / 6	0.0058	0.0058	0.0101	0.0058
Dieldrin	0.0038 :	0.1	1 / 6	0.0006	0.0006	0.0208	0.0006

TABLE A6-1
SURFACE SOIL EXPOSURE POINT CONCENTRATIONS - [Area A01]

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

	Site Data/Concentration [2]						
OHM of Concern [1]	Minimum SQL	Maximum SQL	Frequency of Detection	Minimum	Maximum	Arithmetic Mean	EPC [3]
Endosulfan II	0.0038 :	0.1	1 / 6	0.34	0.34	0.0756	0.0756
PCB-1016	0.26 :	0.27	1 / 3	0.98	0.98	0.415	0.415
Metals (mg/Kg)							
Aluminum			6 / 6	2250	59000	14820	14820
Antimony	1 :	22	2 / 6	54	79	24.2833	24.2833
Arsenic			6 / 6	1.2	24	10.8833	10.8833
Barium			6 / 6	5.4	47	20.3167	20.3167
Beryllium	0.18 :	1.6	1 / 6	4	4	0.9883	0.9883
Cadmium	0.18 :	1.1	1 / 6	5.8	5.8	1.2133	1.2133
Chromium			6 / 6	6.1	5000	1522.5333	1522.53
Cobalt			6 / 6	0.8	45	10.4	10.4
Copper			6 / 6	1.7	35	15.4667	15.4667
Cyanide	2 :	2	2 / 3	5.2	7.5	4.5667	4.5667
Lead			6 / 6	2	62	31.95	31.95
Manganese			6 / 6	9.3	530	128.0667	128.067
Mercury	0.1 :	0.14	4 / 6	0.11	3.2	0.6633	0.6633
Nickel			6 / 6	2.5	67	15.6833	15.6833
Selenium	0.52 :	5.1	3 / 6	0.51	1.5	1.0383	1.0383
Thallium	0.51 :	2.3	1 / 6	1.4	1.4	0.7442	0.7442
Vanadium			6 / 6	4.3	37	17.35	17.35
Zinc			6 / 6	5.6	180	43.8333	43.8333
Inorganics (mg/Kg)							
Chloride			3 / 3	49	560	286.3333	286.333
Nitrogen, Ammonia			4 / 4	43	400	221.5	221.5
Sulfate as SO4			4 / 4	170	2400	990	990

Notes:

1 Selection of OHM of Potential Concern for this medium is presented in "Identification of OHM of Potential Concern - Surface

TABLE A6-1
SURFACE SOIL EXPOSURE POINT CONCENTRATIONS - [Area A01]

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

OHM of Concern [1]	Site Data/Concentration [2]						EPC [3]
	Minimum SQL	Maximum SQL	Frequency of Detection	Minimum	Maximum	Arithmetic Mean	

2 Samples included in Site Data set are presented in "Data Used in Risk Assessment" Appendix.
Duplicate samples were averaged with their original samples prior to calculation of summary statistics.
The arithmetic mean represents the arithmetic average of all sample results, with one-half the reporting limit used as the value for nondetects.
The median represents the median value of all sample results, including non-detects, with the reporting limit used as the value for nondetects.

3 The EPC is the arithmetic mean concentration unless the arithmetic mean concentration exceeds the maximum detected concentration (MADEP, 1995). For these OHM, the maximum detected concentration is used as the EPC.

EPC = Exposure Point Concentration
OHM = Oil or Hazardous Material
SQL = Sample Quantitation Limit

TABLE A6-2
SURFACE SOIL EXPOSURE POINT CONCENTRATIONS - [Area A02]

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

OHM of Concern [1]	Minimum SQL		Maximum SQL	Frequency of Detection	Minimum	Maximum	Arithmetic Mean	EPC [3]
	Site Data/Concentration [2]							
SVOCs (mg/Kg)								
2-Methylnaphthalene	0.52	:	0.52	1 / 2	0.067	0.067	0.1635	0.067
Benzo(a)Anthracene	0.52	:	0.52	1 / 2	0.075	0.075	0.1675	0.075
Benzo(a)Pyrene	0.52	:	0.52	1 / 2	0.057	0.057	0.1585	0.057
Benzo(b)Fluoranthene	0.52	:	0.52	1 / 2	0.13	0.13	0.195	0.13
Benzo(k)Fluoranthene	0.52	:	0.52	1 / 2	0.042	0.042	0.151	0.042
Benzoic Acid	3.7	:	3.7	1 / 2	0.1	0.1	0.975	0.1
Chrysene	0.52	:	0.52	1 / 2	0.15	0.15	0.205	0.15
Di-n-butylphthalate				2 / 2	0.014	0.02	0.017	0.017
Diethylphthalate	0.76	:	0.76	1 / 2	0.033	0.033	0.2065	0.033
Fluoranthene				2 / 2	0.008	0.19	0.099	0.099
Indeno (1,2,3-cd)Pyrene	0.52	:	0.52	1 / 2	0.051	0.051	0.1555	0.051
Naphthalene	0.52	:	0.52	1 / 2	0.049	0.049	0.1545	0.049
Phenanthrene	0.52	:	0.52	1 / 2	0.17	0.17	0.215	0.17
Pyrene				2 / 2	0.011	0.14	0.0755	0.0755
bis(2-EthylHexyl)phthalate				2 / 2	0.13	0.47	0.3	0.3
Pesticides/PCBs (mg/Kg)								
4,4'-DDE	0.037	:	0.037	1 / 2	0.0026	0.0026	0.0106	0.0026
4,4'-DDT	0.037	:	0.037	1 / 2	0.0023	0.0023	0.0104	0.0023
Dieldrin	0.037	:	0.037	1 / 2	0.0008	0.0008	0.0097	0.0008
Gamma-BHC (Lindane)	0.018	:	0.018	1 / 2	0.0001	0.0001	0.0046	0.0001
Heptachlor Epoxide	0.018	:	0.018	1 / 2	0.0001	0.0001	0.0046	0.0001
Metals (mg/Kg)								
Aluminum				2 / 2	2030	5900	3965	3965
Arsenic	1.6	:	1.6	1 / 2	7	7	3.9	3.9
Barium				2 / 2	11.9	38	24.95	24.95
Chromium				2 / 2	3	8.8	5.9	5.9
Cobalt	1.5	:	1.5	1 / 2	0.46	0.46	0.605	0.46

TABLE A6-2
SURFACE SOIL EXPOSURE POINT CONCENTRATIONS - [Area A02]

STAGE II ENVIRONMENTAL RISK CHARACTERIZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

	Site Data/Concentration [2]						
OHM of Concern [1]	Minimum SQL	Maximum SQL	Frequency of Detection	Minimum	Maximum	Arithmetic Mean	EPC [3]
Copper			2 / 2	6.8	12	9.4	9.4
Lead			2 / 2	36	76.3	56.15	56.15
Manganese			2 / 2	1.7	40	20.85	20.85
Mercury	0.14 :	0.14	1 / 2	0.15	0.15	0.11	0.11
Nickel			2 / 2	4.7	5.8	5.25	5.25
Sodium			2 / 2	42	57.1	49.55	49.55
Vanadium			2 / 2	14.5	18	16.25	16.25
Zinc			2 / 2	14.9	31	22.95	22.95
Inorganics (mg/Kg)							
Chloride			1 / 1	68	68	68	68
Nitrogen, Ammonia			1 / 1	25	25	25	25
Sulfate as SO4			1 / 1	4.2	4.2	4.2	4.2

Notes:

1 Selection of OHM of Potential Concern for this medium is presented in "Identification of OHM of Potential Concern - Surface Soil" t

2 Samples included in Site Data set are presented in "Data Used in Risk Assessment" Appendix.
Duplicate samples were averaged with their original samples prior to calculation of summary statistics.
The arithmetic mean represents the arithmetic average of all sample results, with one-half the reporting limit used as the value for nondetects.
The median represents the median value of all sample results, including non-detects, with the reporting limit used as the value for nondetects.

3 The EPC is the arithmetic mean concentration unless the arithmetic mean concentration exceeds the maximum detected concentration (MADEP, 1995). For these OHM, the maximum detected concentration is used as the EPC.

EPC = Exposure Point Concentration
OHM = Oil or Hazardous Material
SQL = Sample Quantitation Limit
MADEP (1995): Guidance for Disposal Site Risk Characterization - In Support of the Massachusetts Contingency Plan (WSC/ORS-95-141, July).

TABLE A6-3
SURFACE SOIL EXPOSURE POINT CONCENTRATIONS - [Area A03]

STAGE II ENVIRONMENTAL RISK CHARACTERIAZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

	Site Data/Concentration [2]						
OHM of Concern [1]	Minimum SQL	Maximum SQL	Frequency of Detection	Minimum	Maximum	Arithmetic Mean	EPC [3]
VOCs (mg/Kg)							
Acetone	0.021 :	0.021	1 / 2	0.093	0.093	0.0518	0.0518
Methylene Chloride	0.02 :	0.02	1 / 2	0.047	0.047	0.0285	0.0285
Tetrachloroethene (PCE)			2 / 2	0.001	0.073	0.037	0.037
Toluene	0.007 :	0.007	1 / 2	0.015	0.015	0.0093	0.0093
SVOCs (mg/Kg)							
Anthracene	0.92 :	2.5	1 / 3	0.002	0.002	0.5707	0.002
Benzo(a)Anthracene	2.5 :	2.5	2 / 3	0.008	0.099	0.4523	0.099
Benzo(a)Pyrene	0.4 :	2.5	1 / 3	0.072	0.072	0.5073	0.072
Benzo(b)Fluoranthene	2.5 :	2.5	2 / 3	0.01	0.16	0.4733	0.16
Benzo(k)Fluoranthene	2.5 :	2.5	2 / 3	0.006	0.039	0.4317	0.039
Benzoic Acid	4.5 :	12	1 / 3	0.039	0.039	2.763	0.039
Butylbenzylphthalate	0.4 :	0.92	1 / 3	2.6	2.6	1.0867	1.0867
Chrysene	2.5 :	2.5	2 / 3	0.012	0.15	0.4707	0.15
Di-n-butylphthalate	0.92 :	0.92	2 / 3	0.05	10	3.5033	3.5033
Di-n-octylphthalate	0.4 :	0.92	1 / 3	4.7	4.7	1.7867	1.7867
Diethylphthalate	0.92 :	2.5	1 / 3	0.01	0.01	0.5733	0.01
Fluoranthene	2.5 :	2.5	2 / 3	0.015	0.2	0.4883	0.2
Indeno (1,2,3-cd)Pyrene	0.4 :	2.5	1 / 3	0.092	0.092	0.514	0.092
N-Nitrosodiphenylamine (1)	0.92 :	0.92	2 / 3	0.075	32	10.845	10.845
Phenanthrene	2.5 :	2.5	2 / 3	0.011	0.15	0.4703	0.15
Phenol	0.4	2.5	0	0	0	0.6367	0
Pyrene	2.5 :	2.5	2 / 3	0.015	0.18	0.4817	0.18
bis(2-EthylHexyl)phthalate			3 / 3	0.53	5500	1833.83	1833.83
Pesticides/PCBs (mg/Kg)							
4,4'-DDE	0.04 :	0.045	1 / 3	0.002	0.002	0.0148	0.002
4,4'-DDT	0.04 :	0.045	1 / 3	0.015	0.015	0.0192	0.015
Alpha-BHC	0.002 :	0.022	1 / 3	0.22	0.22	0.0773	0.0773

TABLE A6-3
SURFACE SOIL EXPOSURE POINT CONCENTRATIONS - [Area A03]

STAGE II ENVIRONMENTAL RISK CHARACTERIAZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

	Site Data/Concentration [2]						
OHM of Concern [1]	Minimum SQL	Maximum SQL	Frequency of Detection	Minimum	Maximum	Arithmetic Mean	EPC [3]
Alpha-Chlordane	0.2 :	0.22	1 / 3	0.0002	0.0002	0.0701	0.0002
Endosulfan II	0.004 :	0.045	1 / 3	0.092	0.092	0.0388	0.0388
Gamma-Chlordane	0.02 :	0.22	1 / 3	0.0003	0.0003	0.0401	0.0003
Metals (mg/Kg)							
Aluminum			3 / 3	5200	8340	6513.3333	6513.3333
Antimony	20 :	20	2 / 3	1.2	76	29.0667	29.0667
Arsenic			3 / 3	4.3	11	7.6	7.6
Barium			3 / 3	11.5	42	24.8333	24.8333
Chromium			3 / 3	19	4500	1666.3333	1666.3333
Cobalt			3 / 3	1.7	2.7	2.0333	2.0333
Copper			3 / 3	6.2	19	14.4	14.4
Lead			3 / 3	8.2	73	32.4	32.4
Manganese			3 / 3	20	54	39	39
Mercury	0.12 :	0.12	2 / 3	0.14	2.8	1	1
Nickel			3 / 3	4	8.1	6.0667	6.0667
Selenium	0.5 :	0.8	1 / 3	0.93	0.93	0.5267	0.5267
Vanadium			3 / 3	14	24	17.8333	17.8333
Zinc			3 / 3	18.7	52	37.5667	37.5667
Inorganics (mg/Kg)							
Nitrogen, Ammonia			2 / 2	39	670	354.5	354.5
Sulfate as SO4			2 / 2	37	82	59.5	59.5

Notes:
1 Selection of OHM of Potential Concern for this medium is presented in "Identification of OHM of Potential Concern - Surface Soil" ta
2 Samples included in Site Data set are presented in "Data Used in Risk Assessment" Appendix.
Duplicate samples were averaged with their original samples prior to calculation of summary statistics.
The arithmetic mean represents the arithmetic average of all sample results, with one-half the reporting limit used as the value for nondetects.

TABLE A6-3
SURFACE SOIL EXPOSURE POINT CONCENTRATIONS - [Area A03]

STAGE II ENVIRONMENTAL RISK CHARACTERIAZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

OHM of Concern [1]	Minimum SQL	Maximum SQL	Frequency of Detection	Site Data/Concentration [2] Minimum	Maximum	Arithmetic Mean	EPC [3]

The median represents the median value of all sample results, including non-detects, with the reporting limit used as the value for nondetects.

3 The EPC is the arithmetic mean concentration unless the arithmetic mean concentration exceeds the maximum detected concentration (MADEP, 1995). For these OHM, the maximum detected concentration is used as the EPC.

EPC = Exposure Point Concentration

OHM = Oil or Hazardous Material

SQL = Sample Quantitation Limit

MADEP (1995): Guidance for Disposal Site Risk Characterization - In Support of the Massachusetts Contingency Plan (WSC/ORS-95-141, July).

TA[illegible]-4
SURFACE SOIL EXPOSURE POINT CONCENTRATIONS - [Area A08]

STAGE II ENVIRONMENTAL RISK CHARACTERIAZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

OHM of Concern [1]	Site Data/Concentration [2]						EPC [3]
	Minimum SQL	Maximum SQL	Frequency of Detection	Minimum	Maximum	Arithmetic Mean	
VOCs (mg/Kg)							
1,1,1-Trichloroethane	0.006 :	0.014	10 / 22	0.002	0.016	0.0067	0.0067
2,4,4-Trimethyl-1-pentene	0.005 :	0.013	5 / 22	0.0008	0.014	0.0043	0.0043
Acetone	0.013 :	0.021	20 / 22	0.006	0.061	0.0208	0.0208
Methylene Chloride	0.005 :	0.014	6 / 22	0.004	0.036	0.0054	0.0054
Toluene	0.005 :	0.013	3 / 22	0.0006	0.005	0.0033	0.0033
SVOCs (mg/Kg)							
2-Methylnaphthalene	0.38 :	4.3	2 / 21	0.007	560	27.0453	27.0453
Acenaphthene	0.38 :	4.3	1 / 21	170	170	8.4841	8.4841
Acenaphthylene	0.38 :	4.3	3 / 21	0.02	420	20.3667	20.3667
Anthracene	0.39 :	4.3	6 / 21	0.01	290	14.1153	14.1153
Benzo(a)Anthracene	0.39 :	4.3	5 / 21	0.015	140	7.0161	7.0161
Benzo(a)Pyrene	0.38 :	4.3	3 / 21	0.034	100	5.1281	5.1281
Benzo(b)Fluoranthene	0.38 :	4.3	4 / 21	0.044	44	2.4527	2.4527
Benzo(g,h,i)Perylene	0.38 :	4.3	2 / 21	0.03	29	1.7607	1.7607
Benzo(k)Fluoranthene	0.38 :	4.3	4 / 21	0.025	66	3.4991	3.4991
Benzoic Acid	1.9 :	770	9 / 21	0.07	1.8	19.38	1.8
Butylbenzylphthalate	0.38 :	160	1 / 21	0.8	0.8	4.2102	0.8
Chrysene	0.39 :	4.3	5 / 21	0.015	150	7.4942	7.4942
Di-n-butylphthalate	0.44 :	160	12 / 21	0.013	1.4	4.042	1.4
Di-n-octylphthalate	0.38 :	160	2 / 21	0.012	0.17	4.1706	0.17
Dibenzofuran	0.38 :	4.3	1 / 21	39	39	2.246	2.246
Diethylphthalate	0.38 :	160	6 / 21	0.015	0.053	4.1075	0.053
Fluoranthene	0.39 :	4.3	8 / 21	0.027	410	19.8202	19.8202
Fluorene	0.38 :	4.3	2 / 21	0.008	430	20.8549	20.8549
Indeno (1,2,3-cd)Pyrene	0.38 :	4.3	3 / 21	0.031	24	1.4995	1.4995
N-Nitrosodiphenylamine (4)	0.39 :	160	3 / 20	0.26	1	4.3093	1
Naphthalene	0.39 :	4.3	3 / 20	0.008	530	26.8656	26.8656

TABLE A6-4
SURFACE SOIL EXPOSURE POINT CONCENTRATIONS - [Area A08]

STAGE II ENVIRONMENTAL RISK CHARACTERIAZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

OHM of Concern [1]	Site Data/Concentration [2]						EPC [3]
	Minimum SQL	Maximum SQL	Frequency of Detection	Minimum	Maximum	Arithmetic Mean	
Phenanthrene	0.39 :	0.96	8 / 20	0.03	1000	50.191	50.191
Phenol	0.39 :	160	1 / 20	2.4	2.4	4.4913	2.4
Pyrene	0.39 :	0.96	9 / 20	0.024	320	16.1793	16.1793
Bis(2-Ethylhexyl)phthalate	0.43 :	160	16 / 21	0.0655	89	10.2296	10.2296
Pesticides/PCBs (mg/Kg)							
4,4'-DDD	0.0039 :	0.045	7 / 21	0.0002	0.017	0.0043	0.0043
4,4'-DDE	0.0039 :	0.045	11 / 21	0.0005	0.011	0.0037	0.0037
4,4'-DDT	0.0039 :	0.045	13 / 21	0.0014	0.04	0.0082	0.0082
Aldrin	0.002 :	0.022	2 / 21	0.0001	0.001	0.0018	0.001
Alpha-BHC	0.002 :	0.022	3 / 21	0.0002	0.0011	0.0019	0.0011
Alpha-Chlordane	0.002 :	0.22	3 / 21	0.0008	0.052	0.009	0.009
Dieldrin	0.0039 :	0.045	8 / 21	0.0004	0.012	0.004	0.004
Endosulfan I	0.002 :	0.022	2 / 21	0.0019	0.099	0.0064	0.0064
Gamma-BHC (Lindane)	0.002 :	0.022	10 / 21	0.0001	0.17	0.0131	0.0131
Gamma-Chlordane	0.002 :	0.22	1 / 21	0.0003	0.0003	0.0066	0.0003
Heptachlor Epoxide	0.002 :	0.022	1 / 21	0.0001	0.0001	0.0019	0.0001
Metals (mg/Kg)							
Aluminum			8 / 8	1700	9100	3671.25	3671.25
Antimony	0.97 :	20	1 / 8	1.3	1.3	1.84	1.3
Arsenic	0.9 :	0.9	7 / 8	2.2	24.5	6.5313	6.5313
Barium			8 / 8	3.6	21	10.85	10.85
Beryllium	0.18	1.5	0	0	0	0.1869	0
Cadmium	0.18	1	0	0	0	0.1556	0
Chromium			21 / 21	2.6	3010	254.7905	254.7905
Cobalt	0.21 :	0.21	7 / 8	0.42	3.9	1.4094	1.4094
Copper			8 / 8	1.1	12	4.325	4.325
Cyanide	2	2	0	0	0	1	0
Lead			8 /	2.3	34	15.2	15.2

TABLE A6-4
SURFACE SOIL EXPOSURE POINT CONCENTRATIONS - [Area A08]

STAGE II ENVIRONMENTAL RISK CHARACTERIAZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

OHM of Concern[1]	Minimum SQL	Maximum SQL	Frequency of Detection	Site Data/Concentration[2] Minimum	Maximum	Arithmetic Mean	EPC[3]
Manganese			8 / 8	3.9	99.9	33.7875	33.7875
Mercury	0.089 :	0.12	4 / 8	0.09	0.38	0.1495	0.1495
Nickel			8 / 8	0.96	9.3	3.295	3.295
Selenium	0.9 :	1.1	3 / 8	1.1	2.2	0.8581	0.8581
Thallium	1.4 :	1.7	1 / 8	0.88	0.88	0.8288	0.8288
Vanadium			8 / 8	4.8	18.4	10.325	10.325
Zinc			8 / 8	4.8	41.4	16.15	16.15
Inorganics (mg/Kg)							
Chloride			1 / 1	110	110	110	110
Nitrogen, Ammonia			19 / 19	15.65	363	163.9079	163.9079
Sulfate as SO4	130 :	430	17 / 19	150	28000	7253.1579	7253.1579

Notes:

1 Selection of OHM of Potential Concern for this medium is presented in "Identification of OHM of Potential Concern - Surface Soil" tabl

2 Samples included in Site Data set are presented in "Data Used in Risk Assessment" Appendix.
Duplicate samples were averaged with their original samples prior to calculation of summary statistics.

The arithmetic mean represents the arithmetic average of all sample results, with one-half the reporting limit used as the value for nondetects.

The median represents the median value of all sample results, including non-detects, with the reporting limit used as the value for nondetects.

3 The EPC is the arithmetic mean concentration unless the arithmetic mean concentration exceeds the maximum detected concentration (MADEP, 1995). For these OHM, the maximum detected concentration is used as the EPC.

EPC = Exposure Point Concentration
OHM = Oil or Hazardous Material
SQL = Sample Quantitation Limit
MADEP (1995): Guidance for Disposal Site Risk Characterization - In Support of the Massachusetts Contingency Plan (WSC/ORS-95-141, July).

TABLE A6-5
SURFACE SOIL EXPOSURE POINT CONCENTRATIONS - [Area A09]

STAGE II ENVIRONMENTAL RISK CHARACTERIAZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

OHM of Concern [1]	Site Data/Concentration [2]						EPC [3]
	Minimum SQL	Maximum SQL	Frequency of Detection	Minimum	Maximum	Arithmetic Mean	
VOCs (mg/Kg)							
1,1,1-Trichloroethane	0.006 :	0.01	1 / 5	0.071	0.071	0.0172	0.0172
Acetone	0.013 :	0.018	3 / 5	0.013	0.026	0.0153	0.0153
Methylene Chloride	0.007 :	0.041	3 / 5	0.004	0.008	0.0082	0.008
Toluene	0.007 :	0.01	1 / 5	0.004	0.004	0.0039	0.0039
SVOCs (mg/Kg)							
Acenaphthene	0.48	0.58	0	0	0	0.2583	0
Acenaphthylene	0.48 :	0.58	1 / 3	0.008	0.008	0.1793	0.008
Anthracene	0.48 :	0.58	1 / 3	0.005	0.005	0.1783	0.005
Benzo(a)anthracene	0.48 :	0.58	1 / 3	0.012	0.012	0.1807	0.012
Benzo(a)pyrene	0.48 :	0.58	1 / 3	0.011	0.011	0.1803	0.011
Benzo(b)fluoranthene	0.48 :	0.58	1 / 3	0.013	0.013	0.181	0.013
Benzo(g,h,i)perylene	0.48	0.58	0	0	0	0.2583	0
Benzo(k)fluoranthene	0.48 :	0.58	1 / 3	0.012	0.012	0.1807	0.012
Benzoic Acid	2.8 :	2.8	2 / 3	0.24	0.36	0.6667	0.36
Chrysene	0.48 :	0.58	1 / 3	0.016	0.016	0.182	0.016
Di-n-butylphthalate			3 / 3	0.013	0.065	0.0327	0.0327
Diethylphthalate	0.58 :	0.58	2 / 3	0.013	0.013	0.1053	0.013
Fluoranthene	0.58 :	0.58	2 / 3	0.011	0.026	0.109	0.026
Phenanthrene	0.58 :	0.58	2 / 3	0.012	0.019	0.107	0.019
Pyrene	0.58 :	0.58	2 / 3	0.013	0.02	0.1077	0.02
bis(2-Ethylhexyl)phthalate			3 / 3	0.19	0.35	0.2867	0.2867
Pesticides/PCBs (mg/Kg)							
4,4'-DDD	0.038 :	0.038	3 / 4	0.0001	0.0005	0.005	0.0005
4,4'-DDE	0.038 :	0.038	3 / 4	0.0016	0.0026	0.0063	0.0026
4,4'-DDT	0.038 :	0.038	3 / 4	0.0014	0.0073	0.0077	0.0073
Aldrin	0.0024 :	0.019	1 / 4	0.0019	0.0019	0.0035	0.0019
Alpha-Chlordane	0.0024 :	0.19	1 / 4	0.0003	0.0003	0.0245	0.0003

TABLE A6-5
SURFACE SOIL EXPOSURE POINT CONCENTRATIONS - [Area A09]

STAGE II ENVIRONMENTAL RISK CHARACTERIAZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

OHM of Concern [1]	Minimum SQL	Maximum SQL	Frequency of Detection	Minimum	Maximum	Arithmetic Mean	EPC [3]
			Site Data/Concentration [2]				
Dieldrin	0.0058 :	0.038	2 / 4	0.0009	0.001	0.006	0.001
Endosulfan I	0.0024 :	0.019	1 / 4	0.0021	0.0021	0.0035	0.0021
Gamma-BHC (Lindane)	0.0024 :	0.019	1 / 4	0.0052	0.0052	0.0043	0.0043
Gamma-Chlordane	0.0024 :	0.19	1 / 4	0.0052	0.0052	0.0257	0.0052
Heptachlor Epoxide	0.0024 :	0.019	1 / 4	0.0004	0.0004	0.0032	0.0004
Metals (mg/Kg)							
Aluminum			4 / 4	2400	5780	4677.5	4677.5
Arsenic			4 / 4	3	9.8	5.75	5.75
Barium			4 / 4	5.3	22	13.175	13.175
Chromium			4 / 4	3.5	38	17.175	17.175
Cobalt	0.24 :	0.24	3 / 4	0.43	2.1	1.0125	1.0125
Copper			4 / 4	2.1	22	8.15	8.15
Cyanide	2	2	0	0	0	1	0
Lead			4 / 4	13.7	210	64.15	64.15
Manganese			4 / 4	3.7	76	24.3	24.3
Mercury	0.11 :	0.18	1 / 4	0.12	0.12	0.0813	0.0813
Nickel	0 :	0	4 / 4	1.5	7.6	3.7	3.7
Selenium	0.5	1.4	0	0	0	0.4838	0
Thallium	1.7 :	2.2	1 / 4	0.8	0.8	0.9125	0.8
Vanadium			4 / 4	6.4	34	16.675	16.675
Zinc			4 / 4	5.1	72	24.5	24.5
Inorganics (mg/Kg)							
Chloride			1 / 1	56	56	56	56
Nitrogen, Ammonia			2 / 2	27	168	97.5	97.5
Sulfate as SO4			2 / 2	83	400	241.5	241.5

Notes:
1 Selection of OHM of Potential Concern for this medium is presented in "Identification of OHM of Potential Concern - Surface Soil" table

TABLE A6-5
SURFACE SOIL EXPOSURE POINT CONCENTRATIONS - [Area A09]

STAGE II ENVIRONMENTAL RISK CHARACTERIAZATION
OLIN CORPORATION, WILMINGTON, MASSACHUSETTS

	Site Data/Concentration [2]							
	Minimum	Maximum	Frequency of			Arithmetic		
[illegible] of Concern	SQL	SQL	Detection	Minimum	Maximum	Mean	EPC [3]

2 Samples included in Site Data set are presented in "Data Used in Risk Assessment" Appendix.
Duplicate samples were averaged with their original samples prior to calculation of summary statistics.
The arithmetic mean represents the arithmetic average of all sample results, with one-half the reporting limit used as the value for nondetects.
The median represents the median value of all sample results, including non-detects, with the reporting limit used as the value for nondetects.
3 The EPC is the arithmetic mean concentration unless the arithmetic mean concentration exceeds the maximum detected concentration (MADEP, 1995). For these OHM, the maximum detected concentration is used as the EPC.
EPC = Exposure Point Concentration
OHM = Oil or Hazardous Material
SQL = Sample Quantitation Limit
MADEP (1995): Guidance for Disposal Site Risk Characterization - In Support of the Massachusetts Contingency Plan (WSC/ORS-95-141, July).

REFERENCES (ATTACHMENT #6)

Massachusetts Department of Environmental Protection (MADEP), 1995. "Guidance for Disposal Site Risk Characterization: In Support of the Massachusetts Contingency Plan"; Bureau of Waste Site Cleanup and Office of Research and Standards; July.